

AD-A207 412

# Center for Night Vision and Electro-Optics

AMSEL-RD-NV-0077

## ENVIRONMENTAL TEST REPORT ON THE CTI-CRYOGENICS 1-WATT INTEGRAL STIRLING COOLER (LONG LIFE HD-1033D)

by

G. Doggett  
H. Dunmire  
R. Samuels  
J. Shaffer

APRIL 1989

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<p>X</p> <p>This final report describes and provides the data on the environmental testing of the CTI-Cryogenics 1-Watt Integral Stirling Cooler (Long Life HD-1033D). The 1-Watt Integral Cooler (HD-1033B/C) is currently used in the M1 FLIR, M60 FLIR, and the Advanced Attack Helicopter FLIR. The long life cooler (clearance seal) improves life of the cooler by approximately two and one half times. C<sup>2</sup>NVEO evaluated the cooler performance at environmental extremes per the purchase description, PD-0182-001(CR). The cooler successfully passed all the environmental tests with no failures.</p> <p>(-21)47</p>					
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or	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>

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Self-Induced Vibration Test of CTI HD-1033D 1-Watt

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**APPENDIX H PURCHASE DESCRIPTION (PD) 0182-001 (CR),**

9/26/86 .....H-1

## SECTION I. INTRODUCTION

The US Army CECOM Center for Night Vision and Electro-Optics (C<sup>2</sup>NVEO) is responsible for developing cryogenic coolers for all infrared imaging systems for the Army. C<sup>2</sup>NVEO also maintains configuration management control of the forward-looking infrared (FLIR) Common Module coolers used in thermal imagers in fielded Army weapon systems such as: M60A3 and M1 Tanks, Bradley Fighting Vehicle System, tube-launched, optically tracked, wire-guided (TOW) Missile System, and Army Attack Helicopters. Currently, there are over 30,000 coolers in fielded systems and several thousand more are added each year. C<sup>2</sup>NVEO conducts development programs and monitors contractor internal research and development efforts to improve cooler performance such as reliability, audio noise, power consumption, and output vibration. One of these efforts has been the development of a clearance seal HD-1033 cooler for the potential use in the tank and helicopter FLIRs. This report covers environmental testing performed by C<sup>2</sup>NVEO on the HD-1033 clearance seal cooler.

The HD-1033 1-Watt Integral Stirling Cooler was originally designed by Texas Instruments in 1974. The cooler requires a 400-hertz (Hz), 117-volt alternating current (vac) power source. The current dynamic seals used on the piston and regenerator of the 1-Watt Integral Cooler are known as *contacting lip seals*. They operate very similar to the compression rings in an automobile engine, in that they rub against the sides of the cylinder. As they rub, they wear out and the particles migrate throughout the cooler. Clearance seals do not rub against the sides of the cylinder and hence do not wear. Compression is maintained by very close tolerances between the regenerator and the coldfinger and the compressor piston and the cylinder. Through the use of clearance seals, the reliability requirement for this cooler has been increased dramatically. The current lip seal 1-Watt Integral Cooler (HD-1033C) has a reliability requirement of 1,000-hour mean-time-to-failure (MTTF), whereas the reliability requirement for the HD-1033D cooler is 2,500-hour MTTF.

Under this test program, CTI-Cryogenics is conducting the life testing on the three units, and the US Army C<sup>2</sup>NVEO performed the environmental testing on two units.

## SECTION II. DESCRIPTION

The environmental portion of the testing was intended to subject the cooler to a series of demanding tests (high temperature, low temperature, temperature shock, imposed vibration, and mechanical shock) to determine if the cooler could be stored and operated under severe climatic and service conditions without experiencing physical damage or deterioration in performance. Cooler vibration output was also measured as a part of this evaluation and this data was compared to standard 1-Watt Integral data. A brief description of each test is provided in Table 1.

Two coolers, S/N D-0008 and S/N D-0012, were selected to undergo all the environmental tests. Baseline acceptance tests were conducted before, during (where applicable), and after each test to determine whether the coolers had passed each test. Additionally, leak rates were performed before and after each test to determine acceptance.

**Table 1. Tests Descriptions**

<b>TEST</b>	<b>REQUIREMENT</b>
Leak Rate	Less than $2.5 \times 10^{-6}$ std cc/sec helium
Acceptance Test	
—Cooldown	Less than 15 minutes to 80°K
—Cooling Capacity	1.0 watt at 80°K
—Input Power	Less than 50 watts
Vibration Output	Translational and rotational forces must meet specified limits for each cooler axis
Temperature Shock	Rapid temperature changes from -62°C to +95°C every 4 hours for 24 hours total
High Temperature	48-hour soak at +95°C, +71°C operation
Low Temperature	24-hour soak at -62°C, -54°C operation
Mechanical Shock	100g peak amplitude for 11 msec
Imposed Vibration	4 to 5g acceleration over 5 to 500 Hz
Restart	After cooling down to 80°K, the cooler must restart within 5 seconds when power is disconnected and reapplied

### SECTION III. TEST RESULTS

All environmental tests were successfully completed by S/N D-0008 and S/N D-0012. There were no failures, relevant or otherwise, and all tests were completed without incident. In addition to testing the coolers at 117 vac, the coolers were also operated at 108 vac during high and low temperature tests. The coolers successfully restarted and operated at 108 vac. The results of the vibration output testing also met the requirements of the purchase description. It should be noted that for comparison purposes, two HD-1033Cs were subjected to the vibration output tests. This data has been provided in Section IV and Appendices A through G. A brief summary of all the performance tests results are provided in Tables 2 and 3. Section IV and Appendices A through G contain the details of each baseline along with all other pertinent data.

The environmental tests portion of this program has been successfully completed. This testing has demonstrated the ability of the clearance seal 1-Watt Integral Cooler to perform satisfactorily during and following exposure to various environmental conditions as specified in the cooler purchase description and MIL-STD-810.

**Table 2. Environmental Test Results—S/N D-0008**

TEST	COOLDOWN 80°K (min)	TEMP (°K) WITH HEAT LOAD	POWER (watts)	LEAK RATE scc He/sec
Initial Baseline	11.45	74.93	41.02	$7.8 \times 10^{-9}$
Post Mechanical Vibration	11.65	75.47	40.80	$1.2 \times 10^{-8}$
Low Temperature	7.80	67.99	35.84	
Post Low Temperature	11.27	73.13	40.44	$1.2 \times 10^{-8}$
Post Temperature Shock	11.33	73.55	41.60	$1.5 \times 10^{-8}$
High Temperature	14.42	68.33	45.51	
Post High Temperature	11.27	73.13	40.84	$1.4 \times 10^{-8}$
Post Mechanical Shock	11.18	72.92	40.96	$1.2 \times 10^{-8}$



**Table 3. Environmental Test Results—S/N D-0012**

<b>TEST</b>	<b>COOLDOWN 80°K (min)</b>	<b>TEMP (°K) WITH HEAT LOAD</b>	<b>POWER (watts)</b>	<b>LEAK RATE scc He/sec</b>
Initial Baseline	11.38	72.25	41.98	$2.0 \times 10^{-8}$
Post Mechanical Vibration	11.27	71.16	42.54	$2.6 \times 10^{-8}$
Low Temperature	8.25	67.51	37.63	
Post Low Temperature	11.27	70.47	42.83	$2.6 \times 10^{-8}$
Post Temperature Shock	11.33	71.43	42.69	$2.8 \times 10^{-8}$
High Temperature	14.67	68.22	47.47	
Post High Temperature	11.27	70.97	43.21	$2.8 \times 10^{-8}$
Post Mechanical Shock	11.20	69.57	43.53	$3.4 \times 10^{-8}$

#### **SECTION IV. APPLICATION TEST DATA**

All environmental test data contained in the appendices appears in chronological order of the testing. The vibration output data is provided in Appendix G.

Performance requirements for the HD-1033D cooler include the ability to maintain a 1-watt heat load at 80°K at an ambient temperature of 23°C, cooldown of a 1,440 joule thermal mass from 300°K to 80°K within 15 minutes at 23°C, and operate under steady state conditions with a heat load applied at room temperature with a power consumption of 50 watts or less.

# APPENDIX A INITIAL BASELINES

## Initial Baseline—S/N D-0008

NEOL DRYGENIC COOLER LAB

CRYOGENIC COOLER DATA

COOLER: CTI D-0008 -- TO 010

DATE: 16 JUNE 88 08:07

VOLTAGE: 117

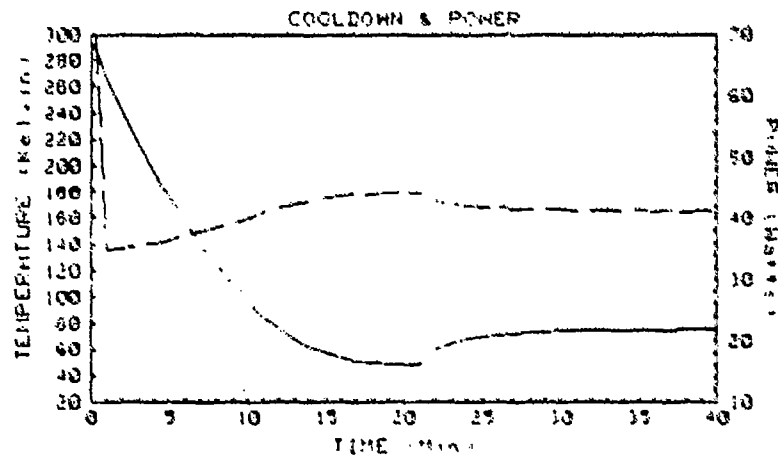
ENGR: HLD

AMBIENT: 23 (C)

DEWAR COMP: -2.355

TEST: BASELINE TEST AS RECEIVED FROM CTI

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	94.82	.415	294.57	0.000
1.00	34.90	.401	267.12	0.000
2.00	35.16	.403	241.00	0.000
3.00	35.65	.406	216.70	0.000
4.00	36.01	.409	195.30	0.000
5.00	36.53	.412	175.27	0.000
6.00	37.10	.417	156.49	0.000
7.00	37.75	.422	139.52	0.000
8.00	38.42	.426	123.45	0.000
9.00	39.19	.432	109.23	0.000
9.70	39.73	.437	99.87	0.000
10.00	39.93	.438	96.31	0.000
11.00	40.89	.446	84.69	0.000
11.45	41.19	.448	79.96	0.000
12.00	41.64	.452	75.01	0.000
13.00	42.31	.457	66.88	0.000
14.00	42.87	.462	60.86	0.000
15.00	43.26	.465	56.42	0.000
16.00	43.66	.468	53.46	0.000
17.00	43.81	.469	51.19	0.000
18.00	43.90	.471	49.88	0.000
19.00	43.99	.471	48.97	0.000
20.00	44.04	.472	48.45	0.000
30.00	41.38	.449	73.70	.999
40.00	41.02	.44	74.93	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $7.8 \times 10^{-9}$  std cc/sec

COMMENTS: As received from CTI.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Dorsett

TEST DATE 13 JUN 88

6.1 Data Summary Sheet Summary Sheet Acceptance Test Procedure - Army Common  
Module Cooler 68863 Assembly TBD, CTI P/N 8194881

S/N: D-0008

Purchase Order No.: DAAJ09-87-C-A039

Reference Paragraph	Requirement	Data
4.6	Test equipment calibration certification is current at time of test.	✓ Accept
5.1 Step 1	Verify that cooler burn in was conducted	✓ Date
5.1 Step 2	Ambient temperature ( $23 \pm 5^{\circ}\text{C}$ )	✓ OC
5.2 Step 1	Cold Station temperature calibrated for LN <sub>2</sub>	✓
5.2 Step 2	Test setup is in accordance with Figure 1	✓ Accept
5.2 Step 3	Test Dewar pressure ( $1.0 \times 10^{-5}$ torr minimum).	✓ Torr
5.2 Step 4	Verify that the cooling fan is operating.	✓ OK
5.2 Step 5	Verify that the strip chart recorder is operating.	✓ Accept
5.3.1	<u>Cooldown Test</u>	
5.3.1 Step 3	Time required for cold station to reach 68K (15 minutes maximum).	<u>17.02</u> Minutes
5.3.2	<u>Cooling Capacity Test</u>	
5.3.2 Step 1	Heat load adjusted to 1.0 watt minimum	✓ Check
5.3.2 Step 2	Temperature of cold station after 30 minutes	<u>76.6</u> K
5.3.2 Step 3	Cooler housing temperature	<u>35.6</u> OC
	Test ambient temperature	<u>22.1</u> OC
	Temperature difference (50C to 150C)	<u>13.2</u> OC
5.3.3	<u>Input Power Test</u>	
5.3.3 Step 1	Input voltage to cooler ( $117 \pm \text{VAC}$ )	<u>117.5</u> VAC
	Input Current to cooler	<u>.44</u> Amps
	Total input power to cooler (50 Watts maximum)	<u>37.6</u> Watts
	Input frequency to cooler ( $480 \pm 20 \text{ Hz}$ )	<u>480</u> Hz
5.3.4	<u>Restart Test (Total of 6 Restarts Completed)</u>	✓ Accept
5.3.5	<u>Leak Rate Test</u>	
	Leak rate is	<u><math>2.4 \times 10^{-8}</math></u> cc/sec
	(Requirements: $2.5 \times 10^{-6}$ cc/sec or less)	
5.4	<u>Inspection</u>	
	Verify that all applicable inspection requirements have been met.	<u>538</u> Inspector
Test Technician	<u>[Signature]</u>	Date <u>4-15-88</u>
Product Engineer	<u>[Signature]</u>	Date <u>4/22/88</u>
Quality Control	<u>R. MacKinnon</u>	Date <u>4-25-88</u>

SIZE	FSC/MO	DWG NO.	REV
A	31949	3864649	B
SCALE		SHEET 9	

# Initial Baseline—S/N D-0012

NVEOL CRYOGENIC COOLER LAB

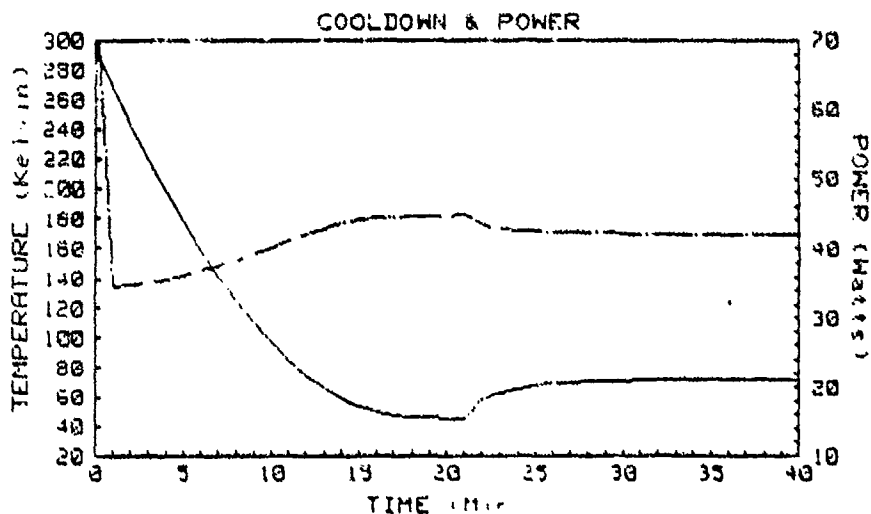
## CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 16 JUNE 88 07:15  
ENGR: HLD  
DEWAR COMP: -2.24

TEST: BASELINE TEST AS RECEIVED FROM CTI

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	80.80	.773	293.42	0.000
1.00	34.52	.417	267.74	0.000
2.00	34.83	.419	242.46	0.000
3.00	35.18	.421	218.95	0.000
4.00	35.70	.424	197.15	0.000
5.00	35.19	.428	177.33	0.000
6.00	36.89	.432	158.56	0.000
7.00	37.55	.436	140.81	0.000
8.00	38.37	.442	124.92	0.000
9.00	39.25	.448	109.97	0.000
9.73	39.88	.453	99.69	0.000
10.00	40.14	.455	96.38	0.000
11.00	41.11	.462	84.38	0.000
11.38	41.39	.465	79.92	0.000
12.00	42.01	.469	73.78	0.000
13.00	42.88	.475	65.16	0.000
14.00	43.49	.481	58.46	0.000
15.00	43.99	.485	53.50	0.000
16.00	44.36	.487	49.93	0.000
17.00	44.47	.489	47.75	0.000
18.00	44.57	.490	46.35	0.000
19.00	44.65	.490	45.44	0.000
20.00	44.72	.490	44.79	0.000
30.00	42.06	.470	71.16	1.000
40.00	41.98	.468	72.35	1.000



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $2.0 \times 10^{-8}$  std cc/sec

COMMENTS: As received from CTI.

\_\_\_\_\_

\_\_\_\_\_

TEST TECHNICIAN G. Dossett

TEST DATE 13 JUN 88

6.1 Data Summary Sheet Summary Sheet Acceptance Test Procedure - Army Common  
Module Cooler 80063 Assembly YBD, CTI P/N 8194001

S/N: D0012

Purchase Order No.: DAAJ09-87-C-AD39

Reference Paragraph	Requirement	Data
4.0	Test equipment calibration certification is current at time of test.	<input checked="" type="checkbox"/> Accept
5.1 Step 1	Verify that cooler burn in was conducted	<u>4-27-88</u> Date
5.1 Step 2	Ambient temperature ( $23 \pm 5^{\circ}\text{C}$ )	<u>22.7</u> $^{\circ}\text{C}$
5.2 Step 1	Cold Station temperature calibrated for LN <sub>2</sub>	<input checked="" type="checkbox"/>
5.2 Step 2	Test setup is in accordance with Figure 1	<input checked="" type="checkbox"/> Accept
5.2 Step 3	Test Dewar pressure ( $1.0 \times 10^{-5}$ torr minimum).	<input checked="" type="checkbox"/> Torr
5.2 Step 4	Verify that the cooling fan is operating.	<input checked="" type="checkbox"/> OK
5.2 Step 5	Verify that the strip chart recorder is operating.	<input checked="" type="checkbox"/> Accept
5.3.1	<u>Cooldown Test</u>	
5.3.1 Step 3	Time required for cold station to reach 80K (15 minutes maximum).	<u>11.61</u> Minutes
5.3.2	<u>Cooling Capacity Test</u>	
5.3.2 Step 1	Heat load adjusted to 1.8 watt minimum	<input checked="" type="checkbox"/> Check
5.3.2 Step 2	Temperature of cold station after 30 minutes	<u>72.6</u> K
5.3.2 Step 3	Cooler housing temperature	<u>34.3</u> $^{\circ}\text{C}$
	Test ambient temperature	<u>22.6</u> $^{\circ}\text{C}$
	Temperature difference ( $5^{\circ}\text{C}$ to $15^{\circ}\text{C}$ )	<u>11.7</u> $^{\circ}\text{C}$
5.3.3	<u>Input Power Test</u>	
5.3.3 Step 1	Input voltage to cooler ( $117 \pm \text{VAC}$ )	<u>117.24</u> VAC
	Input Current to cooler	<u>.470</u> Amps
	Total input power to cooler (50 Watts maximum)	<u>41.2</u> Watts
	Input frequency to cooler ( $400 \pm 20$ Hz)	<u>400</u> Hz
5.3.4	<u>Restart Test (Total of 6 Restarts Completed)</u>	<input checked="" type="checkbox"/> Accept
5.3.5	<u>Leak Rate Test</u>	
	Leak rate is	<u><math>1.2 \times 10^{-7}</math></u> cc/sec
	(Requirement: $2.5 \times 10^{-6}$ cc/sec or less)	
5.4	<u>Inspection</u>	
	Verify that all applicable inspection requirements have been met.	<div style="border: 1px solid black; border-radius: 50%; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 0 auto;">27 CTI</div> Inspector
Test Technician	<u>[Signature]</u>	Date <u>4-29-88</u>
Product Engineer	<u>[Signature]</u> K. M. 6-3-88	Date <u>4-29-88</u>
Quality Control	<u>[Signature]</u> Steven Ross	Date <u>6-6-88</u>

SIZE <b>A</b>	FSCM NO. <b>31949</b>	DWG NO. <b>3864648</b>	REV <b>B</b>
SCALE		SHEET <b>9</b>	

APPENDIX B  
MECHANICAL VIBRATION

Test Report Dated 6/29/88

# NIGHT VISION



DEPARTMENT OF THE ARMY  
HEADQUARTERS, US ARMY COMMUNICATIONS-ELECTRONICS COMMAND  
CENTER FOR NIGHT VISION & ELECTRO-OPTICS  
FORT BELVOIR, VIRGINIA 22060-5677

## TEST REPORT

CRYOGENIC COOLERS  
CTI S/N's D0008 AND D0012



TEST ITEM

Cryogenic Coolers, CTI S/N's D-0008 and D-0012

TEST SPECIFICATION


PD-0182-000(CR), Figure 4, para 4.7.5

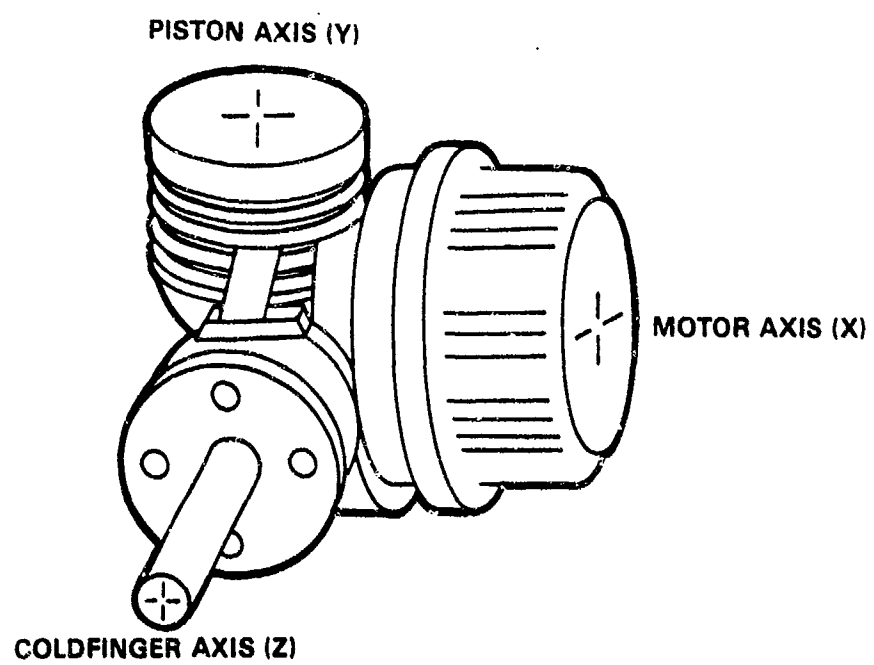
TEST DESCRIPTION

The coolers were operated for five minutes before beginning. The units were then vibrated for 120 minutes using a sine sweep input from 5-500-5 Hz. There were eight (8) such cycles, each 15 minutes long, with the amplitude spectrum shown on the enclosed curve (Encl).

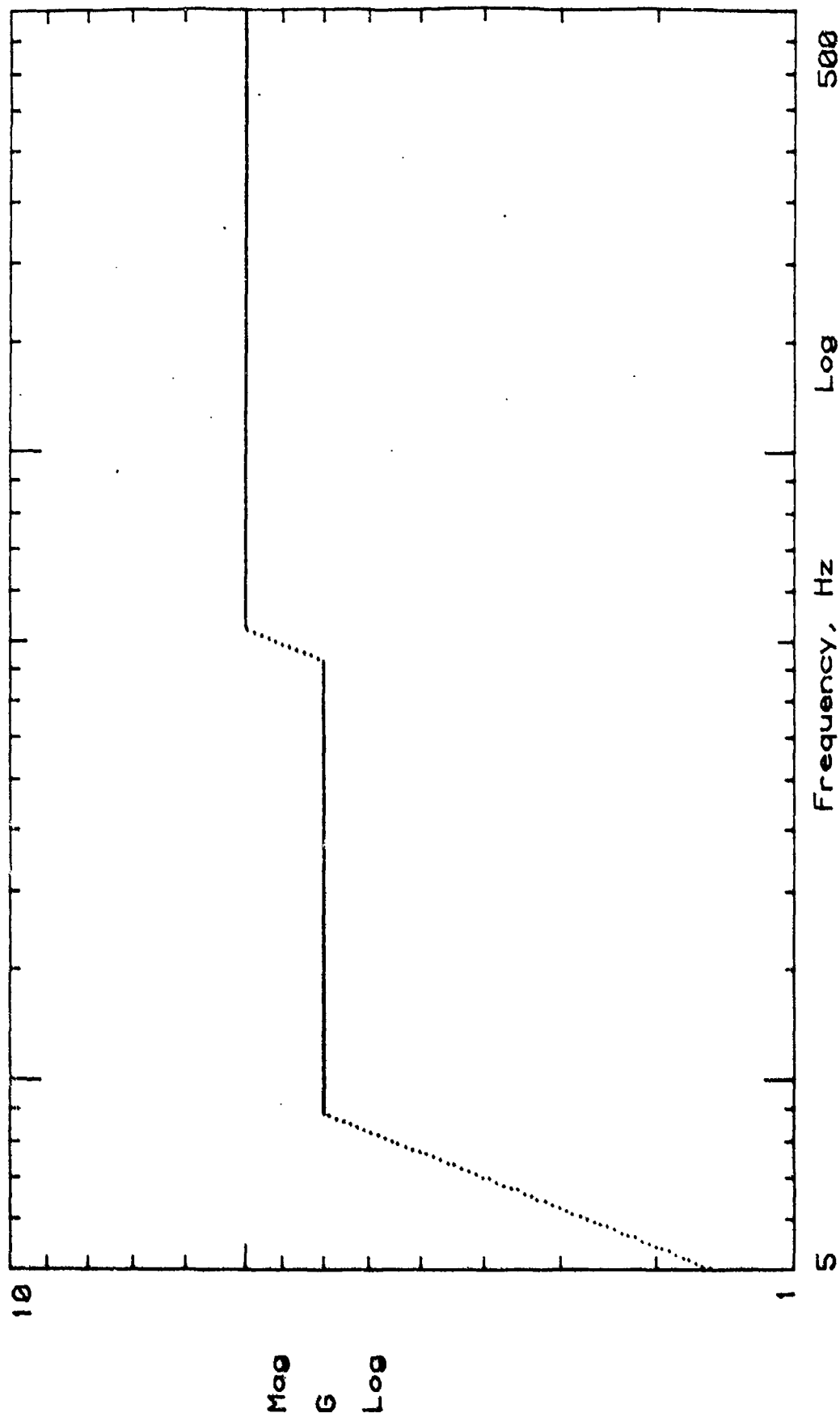
This was performed on all three axes. Both coolers maintained visible frost on the cold finger during all vibrations.

After completion both units were returned to the Far Infrared Engineering Team, Technical Support Division for evaluation.

  
DAVID J. ALLINGHAM  
Test Coordinator  
Support Operations Team  
Technical Support Division  
Center for Night Vision and  
Electro-Optics



**Figure 3. Cooler axes**



CRYOGENIC COOLER TEST SPECTRUM  
CTI1W SPEC. PD-0182-001(CR)

# MECHANICAL VIBRATION—S/N D-0008

NVEOL CRYOGENIC COOLER LAB

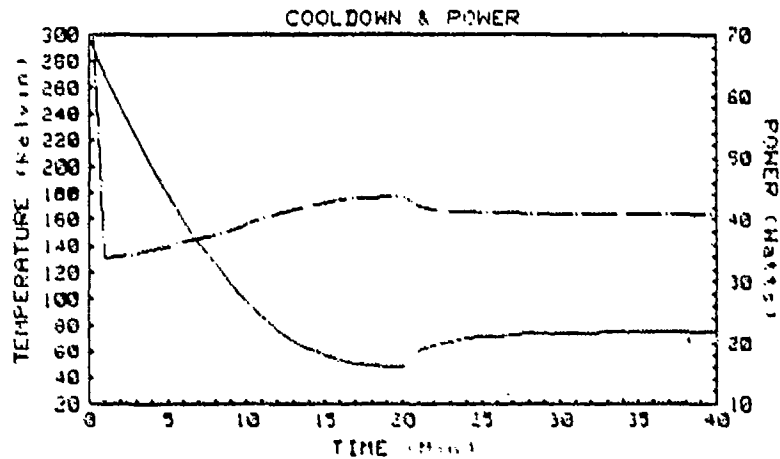
## CRYOGENIC COOLER DATA

COOLER: CTI D-0008  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 21 JUNE 88 14:23  
ENGR: HLD  
DEWAR COMP: -2.355

TEST: PERFORMANCE TEST FOLLOWING MECHANICAL VIBRATION

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	87.04	.804	297.90	0.000
1.00	33.81	.393	270.99	0.000
2.00	34.08	.395	244.30	0.000
3.00	34.52	.399	220.77	0.000
4.00	35.07	.402	198.86	0.000
5.00	35.67	.406	178.65	0.000
6.00	36.42	.411	159.99	0.000
7.00	37.05	.416	142.67	0.000
8.00	37.62	.421	126.73	0.000
9.00	38.36	.426	111.73	0.000
9.88	39.19	.432	100.09	0.000
10.00	39.26	.433	98.62	0.000
11.00	40.17	.440	87.19	0.000
11.65	40.67	.445	79.96	0.000
12.00	40.90	.446	76.74	0.000
13.00	41.63	.453	68.48	0.000
14.00	42.28	.458	61.51	0.000
15.00	42.79	.462	56.83	0.000
16.00	43.21	.465	53.50	0.000
17.00	43.51	.468	51.02	0.000
18.00	43.63	.469	49.62	0.000
19.00	43.73	.469	48.66	0.000
20.00	43.73	.470	48.05	0.000
30.00	40.96	.447	74.43	.999
40.00	40.80	.446	75.47	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $1.2 \times 10^{-8}$  std cc/sec

COMMENTS: Post vibration.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Doggett

TEST DATE 21 JUN 88

# MECHANICAL VIBRATION—S/N D-0012

NVEGL CRYOGENIC COOLER LAB

## CRYOGENIC COOLER DATA

COOLER: CTI D-0012

DATE: 21 JUNE 88 09:12

VOLTAGE: 117

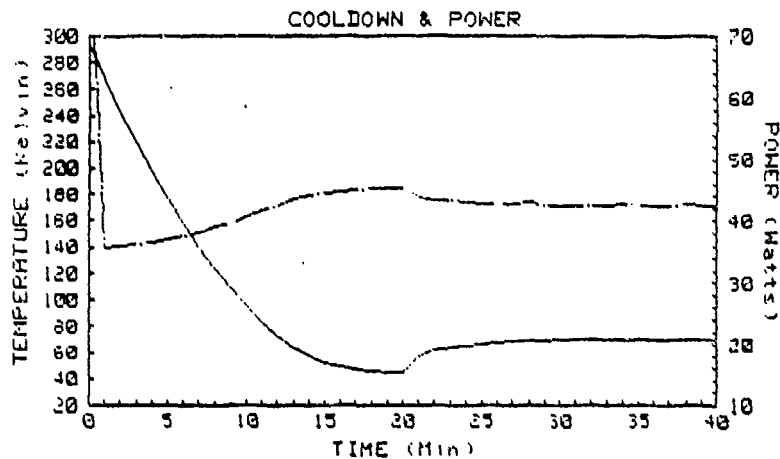
ENGR: HLD

AMBIENT: 23 (C)

DEWAR COMP: -2.24

TEST: PERFORMANCE TEST FOLLOWING MECHANICAL VIBRATION

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	82.34	.793	293.52	0.000
1.00	35.77	.423	287.56	0.000
2.00	35.80	.424	241.83	0.000
3.00	36.10	.425	218.59	0.000
4.00	36.51	.428	196.84	0.000
5.00	36.90	.431	176.59	0.000
6.00	37.36	.434	157.74	0.000
7.00	38.04	.439	140.20	0.000
8.00	39.05	.446	123.89	0.000
9.00	39.68	.451	108.87	0.000
9.65	40.25	.456	99.76	0.000
10.00	40.61	.458	95.35	0.000
11.00	41.62	.466	83.08	0.000
11.27	41.88	.468	79.89	0.000
12.00	42.47	.472	72.63	0.000
13.00	43.49	.480	63.72	0.000
14.00	44.11	.486	57.24	0.000
15.00	44.64	.490	52.64	0.000
16.00	44.91	.492	49.19	0.000
17.00	45.25	.496	47.18	0.000
18.00	45.33	.495	45.79	0.000
19.00	45.49	.497	44.92	0.000
20.00	45.40	.496	44.35	0.000
30.00	42.50	.473	70.20	.999
40.00	42.54	.474	71.16	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $2.6 \times 10^{-8}$  std cc/sec

COMMENTS: Post vibration.

TEST TECHNICIAN G. Dossett

TEST DATE 17 JUN 88

# APPENDIX C LOW TEMPERATURE

Low Temperature—S/N D-0008

## ENVIRONMENTAL TEST DATA SHEET

TEST: LOW TEMPERATURE  
COOLER: 1-WATT INTEGRAL, 1033D  
MANUFACTURER: CTI  
S/N: D-0008  
DATE OF TEST: 28 June 88  
TESTED BY: J. M. Shaffer

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION	21 June 88 1423	1503	✓		✓
4 HOUR SOAK @-62C	0915	1315			✓
RAISE TEMP. TO -54C	1315	1330			✓
STABILIZE @-54C..5HR	1330	1603			✓
OPERATION @-54C	1921	2001	✓		✓
POST TEST PERFORMANCE					
LEAK RATE					



NVEOL CRYOGENIC COOLER LAB

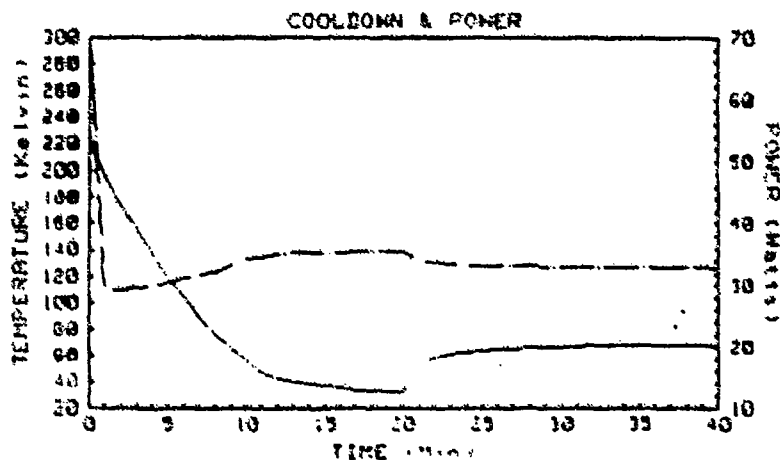
CRYOGENIC COOLER DATA

COOLER: CT1 0-0008  
VOLTAGE: 108  
AMBIENT: -54 (C)

DATE: 28 JUNE 1988 22:27  
ENGR: RNS  
DEWAR COMP: -2.355

TEST: BASELINE AT LOW TEMP (108 V)

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	70.37	.749	218.67	0.000
1.00	29.19	.356	196.21	0.000
2.00	29.18	.357	174.47	0.000
3.00	29.48	.360	154.92	0.000
4.00	29.93	.363	136.84	0.000
5.00	30.30	.366	120.84	0.000
6.00	31.00	.373	104.76	0.000
6.32	31.10	.372	99.83	0.000
7.00	31.63	.376	90.46	0.000
7.80	32.19	.381	79.54	0.000
8.00	32.33	.385	77.80	0.000
9.00	33.15	.390	66.24	0.000
10.00	34.30	.396	55.31	0.000
11.00	34.59	.404	47.40	0.000
12.00	35.15	.407	42.43	0.000
13.00	35.20	.409	39.77	0.000
14.00	35.37	.410	38.03	0.000
15.00	35.49	.410	36.85	0.000
16.00	35.50	.411	35.60	0.000
17.00	35.55	.412	33.94	0.000
18.00	35.63	.413	33.40	0.000
19.00	35.67	.413	32.82	0.000
20.00	35.68	.414	32.44	0.000
30.00	33.87	.390	66.92	.999
40.00	33.91	.388	67.90	.999



# RESTART TEST

TEST TECH JS  
 TEST DATE 28 JUNE 1988

COOLER MANUFACTURER CTI  
 DEWAR MANUFACTURER TEST DEWAR  
 TEMPERATURE SENSOR LAKE SHORE  
 AMBIENT TEMPERATURE -54 C

S/N D-0008  
 S/N TD-010

DATA WHEN COLD FINGER REACHES 75K  
 INPUT VOLTAGE 108 V(AC)  
 CURRENT 0.413 AMPS  
 POWER 31.540 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART

### CYCLE 2

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART

### CYCLE 3

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART

### CYCLE 4

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART

### CYCLE 5

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART

NOTES: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

NVEOL CRYOGENIC COOLER LAB

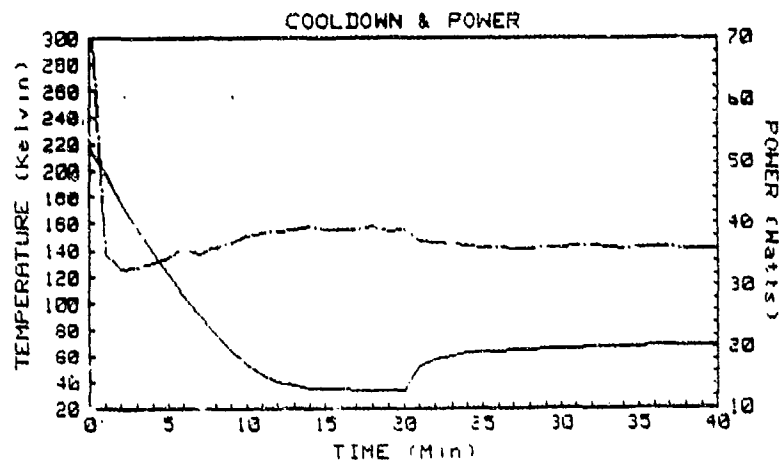
CRYOGENIC COOLER DATA

COOLER: CTI D-0008  
VOLTAGE: 117  
AMBIENT: -54 (C)

DATE: 28 JUNE 1988 19:21  
ENGR: RNS  
DEWAR COMP: -2.355

TEST: BASELINE AT LOW TEMP (117 V)

TIME	POWER	CURRENT	RELVIN	LOAD
0.00	80.08	.790	217.27	0.000
1.00	35.06	.407	97.36	0.000
2.00	32.71	.391	176.25	0.000
3.00	33.10	.399	156.92	0.000
4.00	33.60	.400	138.70	0.000
5.00	34.66	.410	121.91	0.000
6.00	36.16	.407	105.78	0.000
6.40	35.70	.403	99.69	0.000
7.00	35.18	.400	91.16	0.000
7.80	36.05	.417	79.66	0.000
8.00	36.05	.415	77.00	0.000
9.00	36.92	.422	64.17	0.000
10.00	36.13	.430	53.42	0.000
11.00	36.65	.433	44.87	0.000
12.00	38.73	.438	40.00	0.000
13.00	39.06	.438	37.29	0.000
14.00	39.63	.436	35.38	0.000
15.00	39.09	.440	34.28	0.000
16.00	39.13	.442	34.24	0.000
17.00	38.98	.438	33.77	0.000
18.00	39.61	.439	33.46	0.000
19.00	38.94	.437	33.25	0.000
20.00	38.98	.437	33.14	0.000
30.00	36.11	.415	65.81	.999
40.00	35.84	.413	67.99	.999



# RESTART TEST

TEST TECH JS  
 TEST DATE 28 JUNE 1988

COOLER MANUFACTURER CTI  
 DEWAR MANUFACTURER TEST DEWAR  
 TEMPERATURE SENSOR LAKE SHORE  
 AMBIENT TEMPERATURE -54 C

S/N D-0008  
 S/N TD-010

DATA WHEN COLD FINGER REACHES 75K  
 INPUT VOLTAGE 117 V(AC)  
 CURRENT 0.413 AMPS  
 POWER 34.168 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART 1 SEC

### CYCLE 2

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART 1 SEC

### CYCLE 3

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART 1 SEC

### CYCLE 4

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART 1 SEC

### CYCLE 5

OFF 2 SEC X  
 RESTART WITHIN 5 SEC X YES 1 SEC NO  
 TIME REQUIRED TO RESTART 1 SEC

NOTES: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

NVEOL CRYOGENIC COOLER LAB

CRYOGENIC COOLER DATA

COOLER: CTI D-0008

VOLTAGE: 117

AMBIENT: 23 (C)

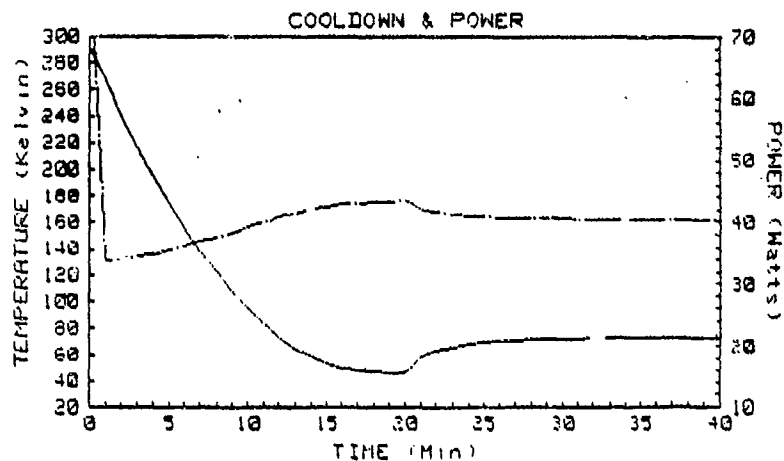
DATE: 29 JUNE 1988 10:15

ENGR: RNS

DEWAR COMP: -2.355

TEST: BASELINE AFTER LOW TEMP TEST

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	83.30	.806	293.00	0.000
1.00	33.70	.393	266.49	0.000
2.00	34.01	.395	240.06	0.000
3.00	34.52	.398	216.45	0.000
4.00	34.97	.402	194.57	0.000
5.00	35.57	.405	174.75	0.000
6.00	35.17	.410	155.88	0.000
7.00	36.84	.415	138.81	0.000
8.00	37.53	.420	122.68	0.000
9.00	38.40	.427	107.87	0.000
9.62	38.87	.431	99.69	0.000
10.00	39.21	.433	94.80	0.000
11.00	40.01	.439	82.81	0.000
11.27	40.22	.441	79.85	0.000
12.00	40.95	.446	72.78	0.000
13.00	41.55	.452	64.17	0.000
14.00	42.32	.458	57.93	0.000
15.00	42.58	.461	53.50	0.000
16.00	42.96	.463	50.19	0.000
17.00	43.14	.465	48.27	0.000
18.00	43.21	.466	47.01	0.000
19.00	43.35	.467	46.18	0.000
20.00	43.51	.468	45.57	0.000
30.00	40.56	.444	72.13	.999
40.00	40.44	.443	73.13	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $1.2 \times 10^{-8}$  std cc/sec

COMMENTS: Post low-temperature testing.

TEST TECHNICIAN G. Doggett

TEST DATE 29 JUN 88

# LOW TEMPERATURE—S/N D-0012

## ENVIRONMENTAL TEST DATA SHEET

TEST: LOW TEMPERATURE  
 COOLER: 1-WATT INTEGRAL, 1033D  
 MANUFACTURER: CTI  
 S/N: D-0012  
 DATE OF TEST: 28 June 88  
 TESTED BY: Jim Shaffer

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION	0912 <sup>28 June 88</sup>	0952	✓		✓
4 HOUR SOAK @ -62C	0915	1315			✓
RAISE TEMP. TO -54C	1315	1330			✓
STABILIZE @ -54C, .5HR	1330	1603			✓
OPERATION @ -54C	1603	1643	✓		✓
POST TEST PERFORMANCE			✓		✓
LEAK RATE			✓		✓

# NVEOL CRYOGENIC COOLER LAB

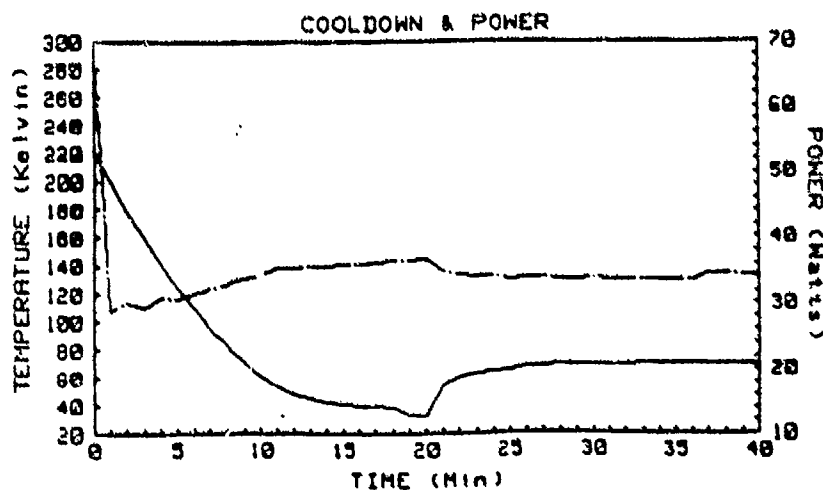
## CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
VOLTAGE: 108  
AMBIENT: -54 (C)

DATE: 28 JUNE 1988 17:17  
ENGR: RNS  
DEWAR COMP: -2.24

TEST: BASELINE AT LOW TEMP (108 V)

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	67.71	.711	219.38	0.000
1.00	38.79	.372	199.52	0.000
2.00	30.12	.374	179.86	0.000
3.00	29.39	.373	159.49	0.000
4.00	30.85	.384	141.84	0.000
5.00	30.66	.384	125.14	0.000
6.00	31.45	.387	109.79	0.000
6.67	32.05	.391	100.02	0.000
7.00	32.45	.392	95.46	0.000
8.00	32.76	.400	82.46	0.000
8.18	33.26	.403	79.96	0.000
9.00	33.74	.412	70.61	0.000
10.00	34.35	.412	60.65	0.000
11.00	35.28	.420	53.14	0.000
12.00	35.39	.422	47.53	0.000
13.00	35.63	.425	44.22	0.000
14.00	35.70	.426	42.26	0.000
15.00	35.84	.426	40.86	0.000
16.00	35.97	.426	40.19	0.000
17.00	36.23	.431	39.47	0.000
18.00	36.32	.428	37.99	0.000
19.00	36.56	.430	33.94	0.000
20.00	36.66	.432	32.37	0.000
30.00	33.68	.404	69.48	.998
40.00	34.43	.414	70.55	.998





# RESTART TEST

TEST TECH B  
TEST DATE 28 JUNE 1988

COOLER MANUFACTURER CTI  
DEWAR MANUFACTURER TEST DEWAR  
TEMPERATURE SENSOR LAKE SHORE  
AMBIENT TEMPERATURE -54 C

S/N D-0012  
S/N TD-011

DATA WHEN COLD FINGER REACHES 75K  
INPUT VOLTAGE 108 V(AC)  
CURRENT 0.415 AMPS  
POWER 31.692 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 2

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 3

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 4

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 5

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

NOTES: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# NVEOL CRYOGENIC COOLER LAB

## CRYOGENIC COOLER DATA

COOLER: CTI D-0012

DATE: 29 JUNE 1989 16:03

VOLTAGE: 117

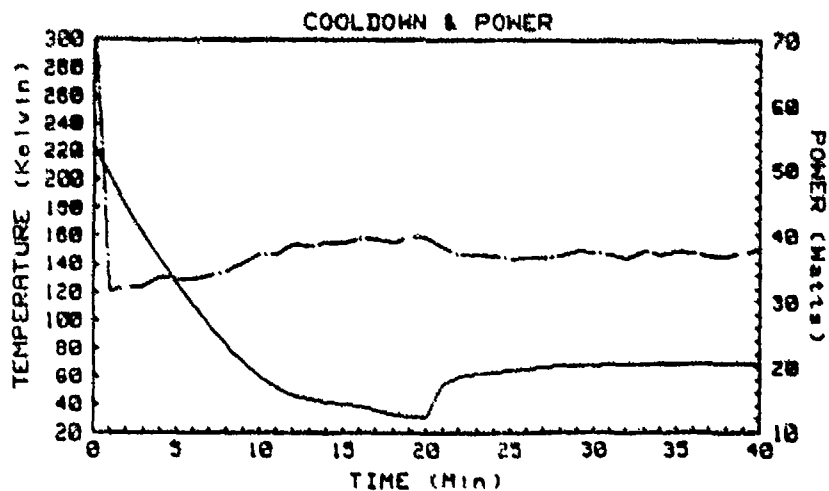
ENGR: RNS

AMBIENT: -54 (C)

DEWAR COMP: -2.24

TEST: BSAELINE AT LOW TEMP (117 V)

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	73.97	.727	221.78	0.000
1.00	31.77	.401	200.74	0.000
2.00	32.59	.405	180.04	0.000
3.00	32.45	.406	161.14	0.000
4.00	33.77	.412	143.24	0.000
5.00	33.45	.410	126.73	0.000
6.00	33.54	.409	110.89	0.000
6.73	33.84	.415	99.87	0.000
7.00	34.13	.415	96.16	0.000
8.00	34.67	.419	82.69	0.000
8.25	35.07	.422	79.27	0.000
9.00	35.97	.430	70.62	0.000
10.00	37.17	.433	60.00	0.000
11.00	37.23	.437	51.80	0.000
12.00	38.90	.444	46.44	0.000
13.00	38.61	.444	43.17	0.000
14.00	39.13	.453	41.08	0.000
15.00	39.15	.459	40.00	0.000
16.00	39.52	.453	38.98	0.000
17.00	39.72	.451	36.21	0.000
18.00	39.15	.453	32.88	0.000
19.00	39.82	.468	31.63	0.000
20.00	39.75	.457	31.16	0.000
30.00	37.42	.442	68.52	.998
40.00	37.63	.437	69.51	.998



# RESTART TEST

TEST TECH B  
 TEST DATE 28 JUNE 1988

COOLER MANUFACTURER CTI  
 DEWAR MANUFACTURER TEST DEWAR  
 TEMPERATURE SENSOR LAKE SHORE  
 AMBIENT TEMPERATURE -54 C

S/N D-0012  
 S/N TD-011

DATA WHEN COLD FINGER REACHES 75K  
 INPUT VOLTAGE 117 V(AC)  
 CURRENT 0.411 AMPS  
 POWER 34.003 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC  
 RESTART WITHIN 5 SEC  
 TIME REQUIRED TO RESTART

X  
X YES 1 NO  
1 SEC

### CYCLE 2

OFF 2 SEC  
 RESTART WITHIN 5 SEC  
 TIME REQUIRED TO RESTART

X  
X YES 1 NO  
1 SEC

### CYCLE 3

OFF 2 SEC  
 RESTART WITHIN 5 SEC  
 TIME REQUIRED TO RESTART

X  
X YES 1 NO  
1 SEC

### CYCLE 4

OFF 2 SEC  
 RESTART WITHIN 5 SEC  
 TIME REQUIRED TO RESTART

X  
X YES 1 NO  
1 SEC

### CYCLE 5

OFF 2 SEC  
 RESTART WITHIN 5 SEC  
 TIME REQUIRED TO RESTART

X  
X YES 1 NO  
1 SEC

NOTES: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

NVEOL CRYOGENIC COOLER LAB

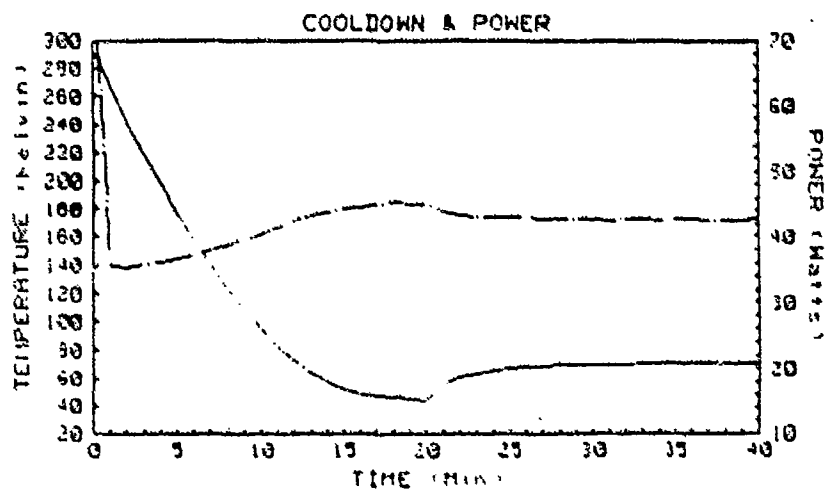
CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 29 JUNE 1988 11:07  
ENGR: RNS  
DEWAR COMP: -2.24

TEST: BASELINE AFTER LOW TEMP TEST

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	81.79	.789	294.15	0.000
1.00	35.54	.423	268.29	0.000
2.00	35.50	.423	242.39	0.000
3.00	35.84	.426	219.06	0.000
4.00	36.18	.427	197.39	0.000
5.00	36.72	.431	177.01	0.000
6.00	37.35	.434	158.24	0.000
7.00	38.13	.440	140.52	0.000
8.00	38.94	.446	124.08	0.000
9.00	39.70	.451	109.23	0.000
9.67	40.14	.455	99.83	0.000
10.00	40.52	.457	95.50	0.000
11.00	41.40	.464	83.04	0.000
11.27	41.71	.466	80.04	0.000
12.00	42.45	.473	72.63	0.000
13.00	43.18	.478	63.64	0.000
14.00	43.90	.484	56.95	0.000
15.00	44.27	.487	52.06	0.000
16.00	44.57	.490	48.88	0.000
17.00	45.20	.494	46.79	0.000
18.00	45.43	.498	45.44	0.000
19.00	45.26	.495	44.52	0.000
20.00	45.18	.495	43.91	0.000
30.00	42.77	.475	69.48	.999
40.00	42.83	.475	70.47	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $2.6 \times 10^{-8}$  std cc/sec

COMMENTS: Post low-temperature testing.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Doggett

TEST DATE 29 JUN 88

# APPENDIX D TEMPERATURE SHOCK

Temperature Shock—S/N D-0008

## ENVIRONMENTAL TEST DATA SHEET

TEST: TEMPERATURE SHOCK

COOLER: 1-WATT INTEGRAL, 1033D

MANUFACTURER: CTI

S/N: D-0008

DATE OF TEST: 29 JUNE 1988 THROUGH 1 JULY 1988

TESTED BY: R. N. SAMUELS

H. G. KLING

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION			✓		
4 HOURS @+95C	29 June 88 1315	1715			✓
4 HOURS @-62C	1715	2115			✓
4 HOURS @+95C	2115	30 June 88 0115			✓
4 HOURS @-62C	0115	0515			✓
4 HOURS @+95C	0515	0915			✓
4 HOURS @-62C	0915	1315			✓
STABILIZE @+23C	1315	1 July 88 0820			✓
OPERATION @+23C	0820	0900	✓		
LEAK RATE	1 July 88		✓		

# NVEOL CRYOGENIC COOLER LAB

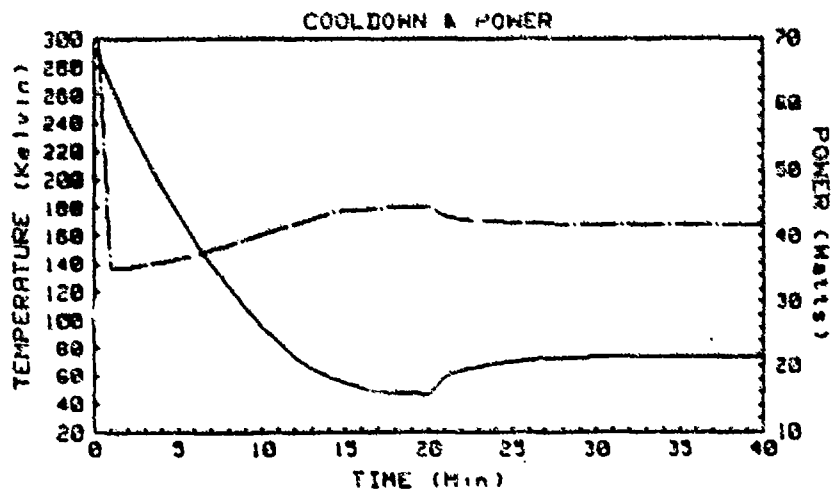
## CRYOGENIC COOLER DATA

COOLER: CTI D-0008  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 1 JULY 1988 09:02  
ENGR: PNS  
DEWAR COMP: -2.355

TEST: POST TEMPERATURE SHOCK BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	84.81	.818	293.91	0.000
1.00	35.15	.402	267.34	0.000
2.00	35.19	.403	241.04	0.000
3.00	35.53	.405	217.05	0.000
4.00	35.94	.409	195.58	0.000
5.00	36.42	.412	175.34	0.000
6.00	37.05	.416	156.05	0.000
7.00	37.72	.421	139.42	0.000
8.00	38.43	.426	123.27	0.000
9.00	39.26	.432	108.72	0.000
9.67	39.75	.437	99.65	0.000
10.00	40.01	.439	95.46	0.000
11.00	40.92	.446	83.58	0.000
11.33	41.18	.449	79.89	0.000
12.00	41.81	.453	73.51	0.000
13.00	42.59	.460	64.91	0.000
14.00	43.28	.466	58.46	0.000
15.00	43.74	.469	53.96	0.000
16.00	43.91	.472	50.75	0.000
17.00	44.22	.473	48.75	0.000
18.00	44.29	.474	47.44	0.000
19.00	44.41	.475	46.62	0.000
20.00	44.36	.474	46.09	0.000
30.00	41.94	.453	72.48	.999
40.00	41.60	.451	73.55	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $1.5 \times 10^{-8}$  std cc/sec

COMMENTS: Post temperature-shock testing.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Doggett

TEST DATE 01 JUL 88



# Temperature Shock—S/N D-0012

## ENVIRONMENTAL TEST DATA SHEET

TEST: TEMPERATURE SHOCK  
 COOLER: 1-WATT INTEGRAL, 1033D  
 MANUFACTURER: CTI  
 S/N: D-0012  
 DATE OF TEST: 29 JUNE / 1 JULY 88  
 TESTED BY: RNS / HGK

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION			✓		
4 HOURS @+95C	29 JUNE 1315	1715			✓
4 HOURS @-62C	1715	2115			✓
4 HOURS @+95C	2115	0115			✓
4 HOURS @-62C	0115	0515			✓
4 HOURS @+95C	0515	0915			✓
4 HOURS @-62C	0915	1315			✓
STABILIZE @+23C	1315	1 JULY 0820			✓
OPERATION @+23C	0820	0900	✓		
LEAK RATE	1 JULY		✓		

# NVEOL CRYOGENIC COOLER LAB

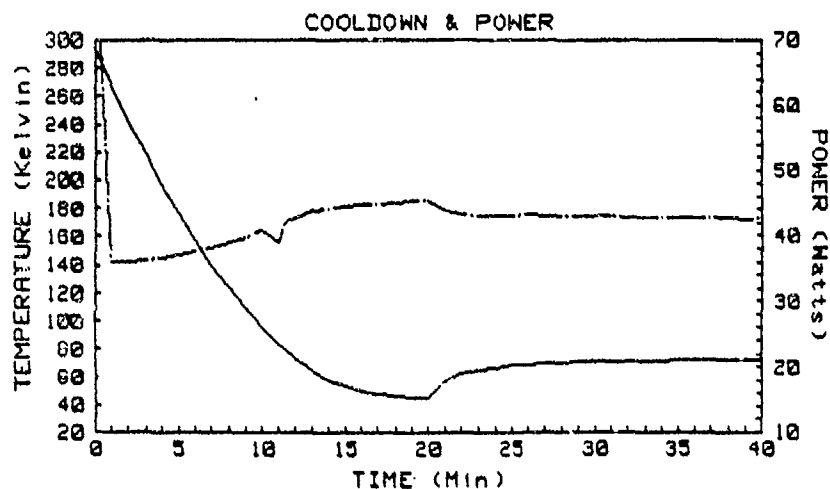
## CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 1 JULY 1980 11:09  
ENGR: RNS  
DEWAR COMP: -2.24

TEST: POST TEMPERATURE SHOCK BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	82.29	.792	293.45	0.000
1.00	36.20	.437	267.34	0.000
2.00	36.19	.435	241.83	0.000
3.00	36.37	.431	218.34	0.000
4.00	36.80	.434	196.45	0.000
5.00	37.19	.435	176.49	0.000
6.00	37.81	.438	157.45	0.000
7.00	38.35	.442	140.13	0.000
8.00	39.17	.447	123.71	0.000
9.00	39.96	.453	108.87	0.000
9.67	40.56	.457	99.58	0.000
10.00	40.88	.459	95.24	0.000
11.00	38.99	.467	83.23	0.000
11.33	42.22	.470	79.46	0.000
12.00	42.86	.474	72.71	0.000
13.00	43.83	.482	64.01	0.000
14.00	44.20	.485	57.44	0.000
15.00	44.64	.489	52.89	0.000
16.00	44.89	.491	49.45	0.000
17.00	45.02	.491	47.40	0.000
18.00	45.19	.492	46.09	0.000
19.00	45.33	.494	45.22	0.000
20.00	45.29	.494	44.61	0.000
30.00	43.01	.474	70.47	.999
40.00	42.69	.472	71.43	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $2.8 \times 10^{-8}$  std cc/sec

COMMENTS: Post temperature-shock testing.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Doggett

TEST DATE 01 JUL 88

# APPENDIX E HIGH TEMPERATURE

High Temperature—S/N D-0008

## ENVIRONMENTAL TEST DATA SHEET

TEST: HIGH TEMPERATURE  
COOLER: 1-WATT INTEGRAL, 1033D  
MANUFACTURER: CTI  
S/N: D0008  
DATE OF TEST: 5-8 JULY 88  
TESTED BY: JIM SHAFFER

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION			✓		
48 HOUR SOAK @+95C	0755 5 JULY	0755 7 JULY			✓
LOWER TEMP. TO +71C	0755 7 JULY	1130 7 JULY			✓
STABILIZE @+71C, .5HR	1130 7 JULY	1928 7 JULY			✓
OPERATION @+71C	1717	1757	✓		
POST TEST PERFORMANCE	0939 8 JULY	1019 8 JULY	✓		
LEAK RATE	8 JULY	8 JULY	✓		

# NVEOL CRYOGENIC COOLER LAB

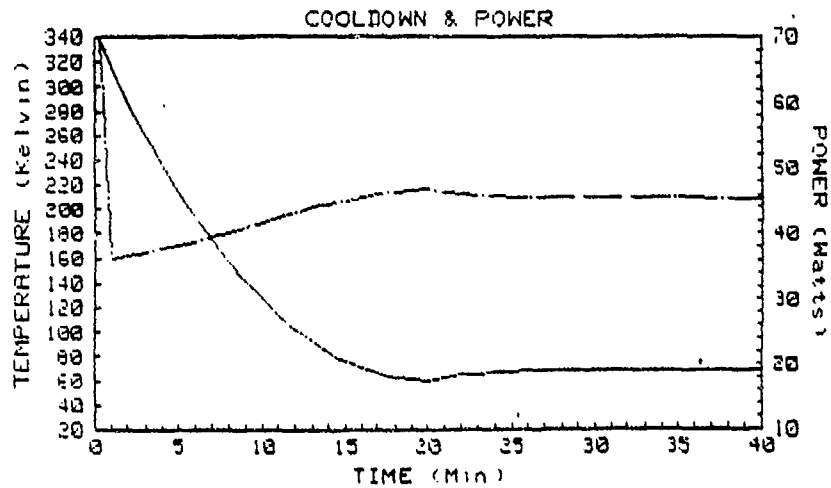
## CRYOGENIC COOLER DATA

COOLER: CTI D-0008  
VOLTAGE: 117  
AMBIENT: 71 (C)

DATE: 7 JULY 1988 17:17  
ENGR: RNS  
DEWAR COMP: -2.355

TEST: HIGH TEMP BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	85.34	.820	345.20	0.000
1.00	36.23	.408	315.42	0.000
2.00	36.59	.411	286.06	0.000
3.00	37.12	.415	260.02	0.000
4.00	37.63	.419	235.78	0.000
5.00	38.23	.423	213.95	0.000
6.00	38.77	.427	193.67	0.000
7.00	39.48	.432	174.99	0.000
8.00	40.17	.438	157.35	0.000
9.00	40.84	.442	141.45	0.000
10.00	41.64	.449	127.05	0.000
11.00	42.49	.455	113.50	0.000
12.00	43.28	.463	101.86	0.000
12.17	43.32	.463	100.02	0.000
13.00	44.18	.470	91.71	0.000
14.00	44.65	.474	83.00	0.000
14.42	44.83	.475	79.73	0.000
15.00	45.20	.478	75.89	0.000
16.00	45.75	.484	70.43	0.000
17.00	46.11	.487	66.02	0.000
18.00	46.50	.490	62.74	0.000
19.00	46.80	.492	60.41	0.000
20.00	46.92	.493	58.78	0.000
30.00	45.62	.482	68.06	.500
40.00	45.51	.481	68.33	.500



# RESTART TEST

TEST TECH KS  
TEST DATE 7 JULY 1988

COOLER MANUFACTURER	<u>CTI</u>	S/N	<u>D-0008</u>
DEWAR MANUFACTURER	<u>TEST DEWAR</u>	S/N	<u>TD-010</u>
TEMPERATURE SENSOR	<u>LAKE SHORE</u>		
AMBIENT TEMPERATURE	<u>+71</u> C		

DATA WHEN COLD FINGER REACHES 75K  
INPUT VOLTAGE 117 V(AC)  
CURRENT 0.476 AMPS  
POWER 39.380 WATTS

## RESTART TEST

CYCLE 1			
OFF 2 SEC	<u>X</u>		
RESTART WITHIN 5 SEC	<u>X</u> YES		NO
TIME REQUIRED TO RESTART	<u>1</u> SEC		
CYCLE 2			
OFF 2 SEC	<u>X</u>		
RESTART WITHIN 5 SEC	<u>X</u> YES		NO
TIME REQUIRED TO RESTART	<u>1</u> SEC		
CYCLE 3			
OFF 2 SEC	<u>X</u>		
RESTART WITHIN 5 SEC	<u>X</u> YES		NO
TIME REQUIRED TO RESTART	<u>1</u> SEC		
CYCLE 4			
OFF 2 SEC	<u>X</u>		
RESTART WITHIN 5 SEC	<u>X</u> YES		NO
TIME REQUIRED TO RESTART	<u>1</u> SEC		
CYCLE 5			
OFF 2 SEC	<u>X</u>		
RESTART WITHIN 5 SEC	<u>X</u> YES		NO
TIME REQUIRED TO RESTART	<u>1</u> SEC		

NOTES: The cooler died on every test cycle.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# RESTART TEST

TEST TECH JKS  
TEST DATE 7 JULY 1988

COOLER MANUFACTURER CTI  
DEWAR MANUFACTURER TEST DEWAR  
TEMPERATURE SENSOR LAKE SHORE  
AMBIENT TEMPERATURE +71 C

S/N D-0008  
S/N TD-010

DATA WHEN COLD FINGER REACHES 75K  
INPUT VOLTAGE 108 V(AC)  
CURRENT 0.465 AMPS  
POWER 35.511 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 2

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 3

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 4

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 5

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

NOTES: The cooler died on cycles 1, 2, 3, & 5.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

NVEOL CRYOGENIC COOLER LAB

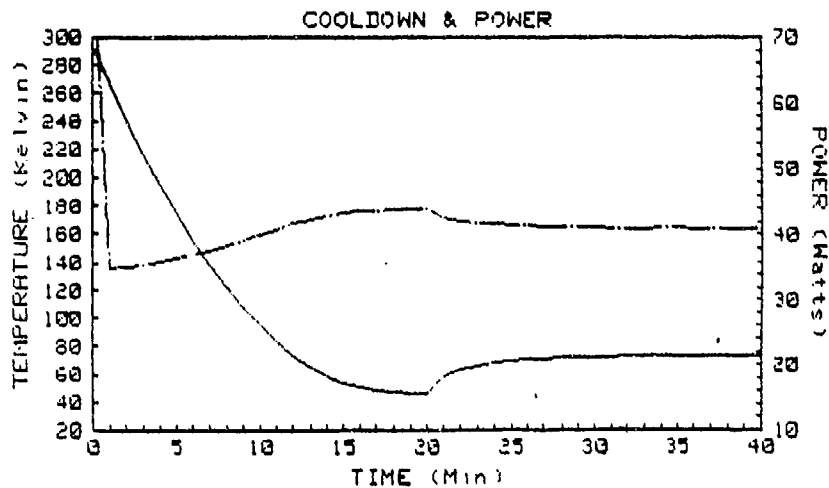
CRYOGENIC COOLER DATA

COOLER: CTI D-0008  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 8 JULY 1988 09:39  
ENGR: RNS  
DEWAR COMP: -2.355

TEST: POST HIGH TEMP BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	84.27	.815	293.56	0.000
1.00	34.83	.400	266.82	0.000
2.00	35.14	.402	240.33	0.000
3.00	35.48	.405	216.73	0.000
4.00	35.92	.408	194.71	0.000
5.00	36.38	.412	174.89	0.000
6.00	37.05	.416	156.28	0.000
7.00	37.60	.420	138.81	0.000
8.00	38.40	.426	122.90	0.000
9.00	39.18	.432	107.95	0.000
9.60	39.72	.437	99.72	0.000
10.00	39.95	.438	94.87	0.000
11.00	40.75	.445	82.81	0.000
11.27	41.04	.448	79.92	0.000
12.00	41.67	.452	72.86	0.000
13.00	42.30	.457	64.29	0.000
14.00	42.84	.462	57.93	0.000
15.00	43.25	.466	53.63	0.000
16.00	43.49	.468	50.36	0.000
17.00	43.64	.470	48.45	0.000
18.00	43.76	.470	47.18	0.000
19.00	43.82	.471	46.40	0.000
20.00	43.93	.471	45.87	0.000
30.00	41.08	.448	72.13	.997
40.00	40.84	.446	73.13	.997





ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $1.4 \times 10^{-8}$  std cc/sec

COMMENTS: Post high-temperature testing.  
   
 

TEST TECHNICIAN R. Samuels

TEST DATE 08 JUL 88

# High Temperature— S/N D-0012

## ENVIRONMENTAL TEST DATA SHEET

TEST: HIGH TEMPERATURE  
 COOLER: 1-WATT INTEGRAL, 1033D  
 MANUFACTURER: CTI  
 S/N: D-0012  
 DATE OF TEST: 5-8 JULY 88  
 TESTED BY: JIM SHAPPER

PARAMETER	START	END	PASS	FAIL	COMPLY
PRE-TEST OPERATION			✓		
48 HOUR SOAK @+95C	0755 5 JULY	0755 7 JULY			✓
LOWER TEMP. TO +71C	0755 7 JULY	1130 7 JULY			✓
STABILIZE @+71C..5HR	1130 7 JULY	1528 7 JULY			✓
OPERATION @+71C	1528	1608	✓		
POST TEST PERFORMANCE	1053 8 JULY	1133 8 JULY	✓		
LEAK RATE	8 JULY	8 JULY	✓		

# NVEOL CRYOGENIC COOLER LAB

## CRYOGENIC COOLER DATA

COOLER: CTI D-0012

DATE: 7 JULY 1988 15:28

VOLTAGE: 117

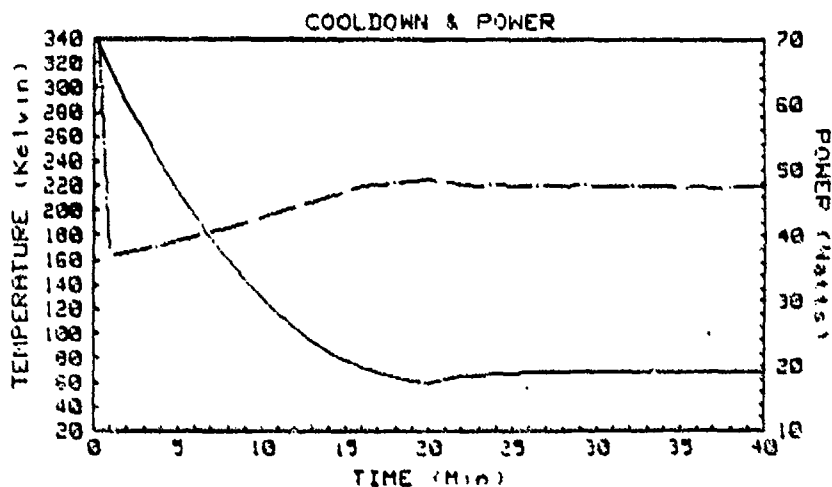
ENGR: RNS

AMBIENT: 71 (C)

DEWAR COMP: -2.24

TEST: HIGH TEMP BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	82.51	.792	343.83	0.000
1.00	37.06	.434	315.66	0.000
2.00	37.59	.436	287.67	0.000
3.00	38.07	.440	262.36	0.000
4.00	38.47	.443	238.67	0.000
5.00	39.23	.447	216.55	0.000
6.00	39.89	.452	196.49	0.000
7.00	40.68	.457	177.67	0.000
8.00	41.27	.461	160.46	0.000
9.00	41.98	.467	144.24	0.000
10.00	42.81	.473	129.52	0.000
11.00	43.49	.478	116.18	0.000
12.00	44.39	.484	104.32	0.000
12.40	44.77	.487	99.91	0.000
13.00	45.28	.492	93.95	0.000
14.00	46.07	.498	85.04	0.000
14.57	46.56	.502	79.73	0.000
15.00	46.74	.504	77.43	0.000
16.00	47.45	.509	71.88	0.000
17.00	47.78	.511	67.53	0.000
18.00	48.15	.515	63.72	0.000
19.00	48.41	.517	61.31	0.000
20.00	48.58	.519	59.47	0.000
30.00	47.55	.510	67.91	.500
40.00	47.47	.510	68.22	.500



# RESTART TEST

TEST TECH KS  
TEST DATE 7 JULY 1988

COOLER MANUFACTURER CTI  
DEWAR MANUFACTURER TEST DEWAR  
TEMPERATURE SENSOR LAKE SHORE  
AMBIENT TEMPERATURE +71 C

S/N D-0012  
S/N TD-011

DATA WHEN COLD FINGER REACHES 75K  
INPUT VOLTAGE 108 V(AC)  
CURRENT 0.491 AMPS  
POWER 37.496 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 2

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 3

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 4

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

### CYCLE 5

OFF 2 SEC X  
RESTART WITHIN 5 SEC X YES 1 SEC NO  
TIME REQUIRED TO RESTART

NOTES: The cooler dicsled on every test cycle.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# RESTART TEST

TEST TECH KS  
TEST DATE 7 JULY 1988

COOLER MANUFACTURER CTI  
DEWAR MANUFACTURER TEST DEWAR  
TEMPERATURE SENSOR LAKE SHORE  
AMBIENT TEMPERATURE +71 C

S/N D-0012  
S/N TD-011

DATA WHEN COLD FINGER REACHES 75K  
INPUT VOLTAGE 108 V(AC)  
CURRENT 0.491 AMPS  
POWER 37.496 WATTS

## RESTART TEST

### CYCLE 1

OFF 2 SEC  
RESTART WITHIN 5 SEC  
TIME REQUIRED TO RESTART

X  
X YES 1 SEC NO

### CYCLE 2

OFF 2 SEC  
RESTART WITHIN 5 SEC  
TIME REQUIRED TO RESTART

X  
X YES 1 SEC NO

### CYCLE 3

OFF 2 SEC  
RESTART WITHIN 5 SEC  
TIME REQUIRED TO RESTART

X  
X YES 1 SEC NO

### CYCLE 4

OFF 2 SEC  
RESTART WITHIN 5 SEC  
TIME REQUIRED TO RESTART

X  
X YES 1 SEC NO

### CYCLE 5

OFF 2 SEC  
RESTART WITHIN 5 SEC  
TIME REQUIRED TO RESTART

X  
X YES 1 SEC NO

NOTES: The cooler dicsled on every test cycle.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# NVEOL CRYOGENIC COOLER LAB

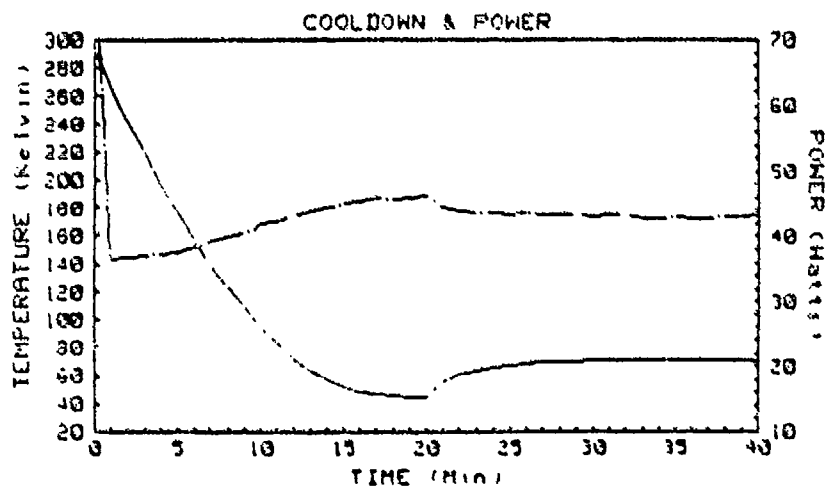
## CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
VOLTAGE: 117  
AMBIENT: 23 (C)

DATE: 8 JULY 1988 10:53  
ENGR: RNS  
DEWAR COMP: -2.24

TEST: POST HIGH TEMP BASELINE

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	81.83	.786	293.03	0.000
1.00	36.43	.434	267.19	0.000
2.00	36.77	.436	241.45	0.000
3.00	37.06	.439	218.24	0.000
4.00	37.35	.440	196.38	0.000
5.00	77.53	.441	176.46	0.000
6.00	38.35	.446	157.35	0.000
7.00	38.95	.451	139.70	0.000
8.00	39.78	.457	123.64	0.000
9.00	40.51	.462	108.57	0.000
9.67	41.02	.466	99.32	0.000
10.00	41.91	.472	94.98	0.000
11.00	42.37	.478	82.89	0.000
11.27	42.50	.479	79.89	0.000
12.00	43.06	.482	72.36	0.000
13.00	43.88	.488	63.68	0.000
14.00	44.30	.491	56.99	0.000
15.00	45.11	.498	52.10	0.000
16.00	45.29	.499	48.92	0.000
17.00	45.84	.502	46.96	0.000
18.00	45.65	.501	45.57	0.000
19.00	45.98	.505	44.65	0.000
20.00	46.08	.505	44.13	0.000
30.00	43.10	.484	70.01	.998
40.00	43.21	.483	70.97	.998



## ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

### COOLDOWN TEST

TIME REQUIRED TO REACH 100K N/A MINUTES

TIME REQUIRED TO REACH 1.02 V N/A MINUTES

TIME REQUIRED TO REACH 80K N/A MINUTES

TEMPERATURE AFTER 20 MINUTES N/A K

LEAK RATE:  $2.8 \times 10^{-8}$  std cc/sec

COMMENTS: Post high-temperature testing.

TEST TECHNICIAN R. Samuels

TEST DATE 08 JUL 88

**APPENDIX F**  
**MECHANICAL SHOCK**

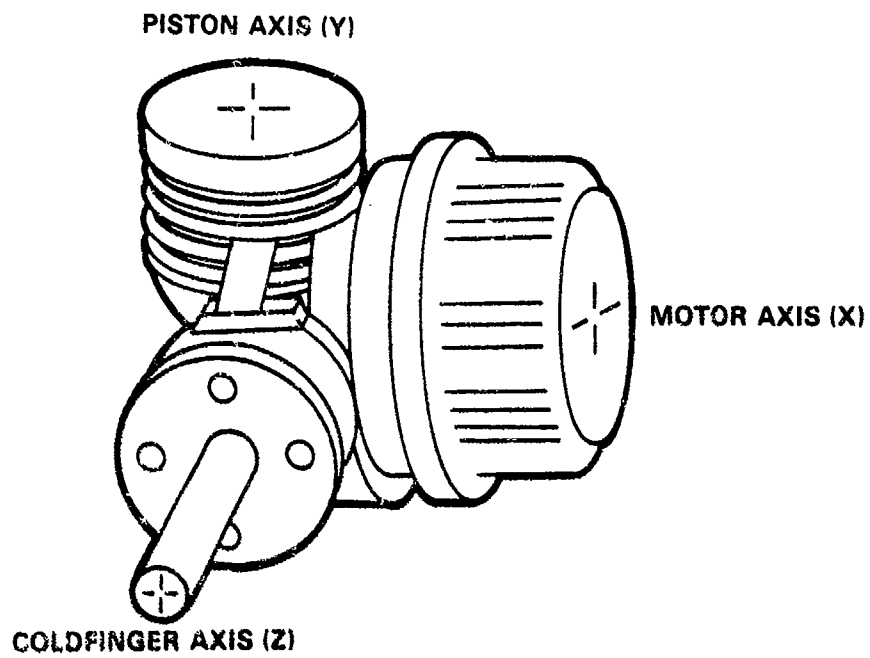
**Mechanical Shock--S/N D-0008**

**ENVIRONMENTAL TEST DATA SHEET**

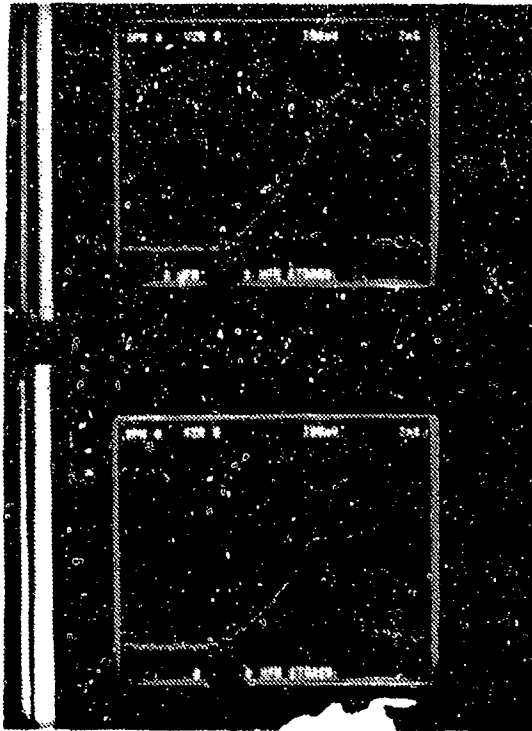
TEST: MECHANICAL SHOCK  
COOLER: 1-WATT INTEGRAL, 103°D  
MANUFACTURER: CTI  
S/N: D-0008  
DATE OF TEST: 21 JULY 88  
TESTED BY: RNS

PARAMETER	PASS	FAIL	COMPLY
PRE-TEST OPERATION	✓		
12 SHOCKS TOTAL			✓
POST TEST PERFORMANCE	✓		
LEAK RATE			✓

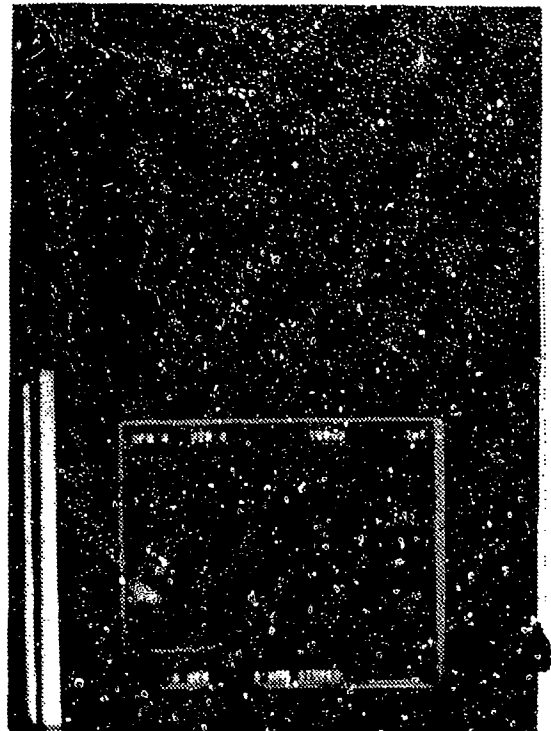




**Figure 3. Cooler axes**



(+) COLD FINGER AXIS



(-) COLD FINGER AXIS\*

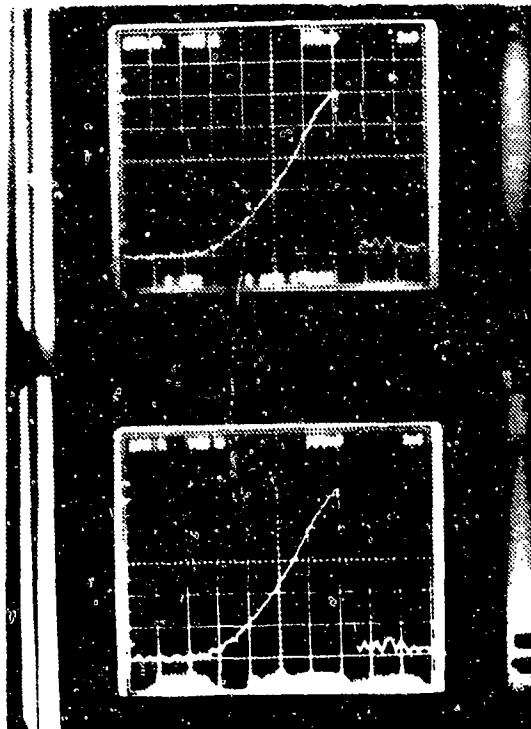
\* First drop data was not recorded due to the failure of the oscilloscope to receive the triggering signal.



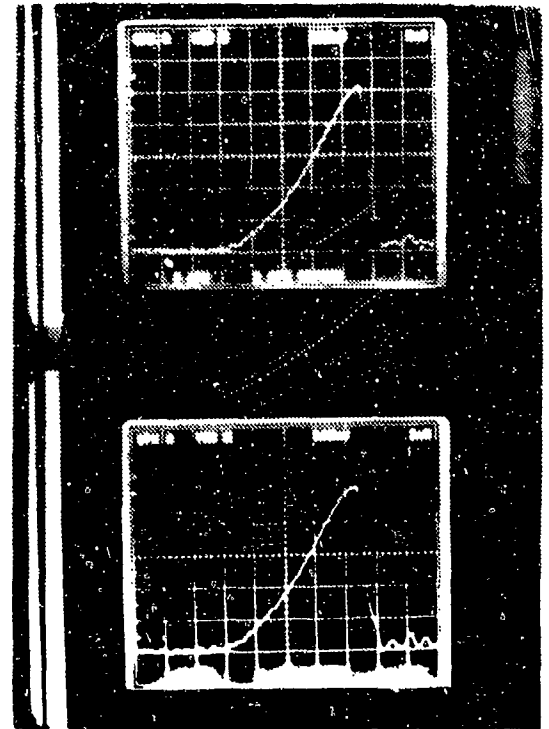
(+) MOTOR AXIS



(-) MOTOR AXIS



(+) PISTON AXIS



(-) PISTON AXIS

# NVEOL CRYOGENIC COOLER LAB

## CRYOGENIC COOLER DATA

COOLER: CTI D-0008 / TD-010

DATE: 21 JULY 88 09:44

VOLTAGE: 117

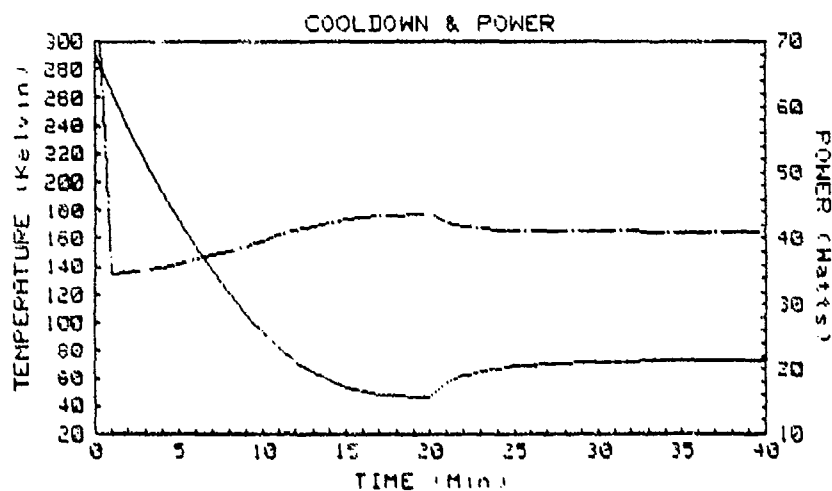
ENGR: HLD

AMBIENT: 23 (C)

DEWAR COMP: -2.355

TEST: PERFORMANCE TEST FOLLOWING MECHANICAL SHOCK

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	83.33	.808	291.31	0.000
1.00	34.60	.399	264.47	0.000
2.00	34.92	.401	238.38	0.000
3.00	35.27	.404	214.20	0.000
4.00	35.67	.407	192.63	0.000
5.00	36.23	.411	172.46	0.000
6.00	36.88	.415	154.03	0.000
7.00	37.48	.420	136.81	0.000
8.00	38.09	.425	120.91	0.000
9.00	38.81	.430	106.66	0.000
9.53	39.32	.434	99.54	0.000
10.00	39.72	.437	93.66	0.000
11.00	40.53	.444	82.18	0.000
11.18	40.73	.445	79.99	0.000
12.00	41.34	.451	72.23	0.000
13.00	42.00	.456	64.07	0.000
14.00	42.58	.462	58.06	0.000
15.00	43.03	.465	53.53	0.000
16.00	43.28	.467	50.66	0.000
17.00	43.52	.469	48.31	0.000
18.00	43.67	.470	47.01	0.000
19.00	43.75	.471	46.09	0.000
20.00	43.77	.471	45.48	0.000
30.00	41.11	.449	71.89	.998
40.00	40.96	.447	72.92	.998



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0008

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1.02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $1.2 \times 10^{-8}$  std cc/sec

COMMENTS: Post shock testing.

TEST TECHNICIAN G. Doggett

TEST DATE 22 JUL 88

ENVIRONMENTAL TEST DATA SHEET

TEST: MECHANICAL SHOCK  
 COOLER: 1-WATT INTEGRAL, 1033D  
 MANUFACTURER: CTI  
 S/N: D-0012  
 DATE OF TEST: 21 JULY 88  
 TESTED BY: RNS

PARAMETER	PASS	FAIL	COMPLY
PRE-TEST OPERATION	✓		
12 SHOCKS TOTAL			✓
POST TEST PERFORMANCE	✓		
LEAK RATE			✓

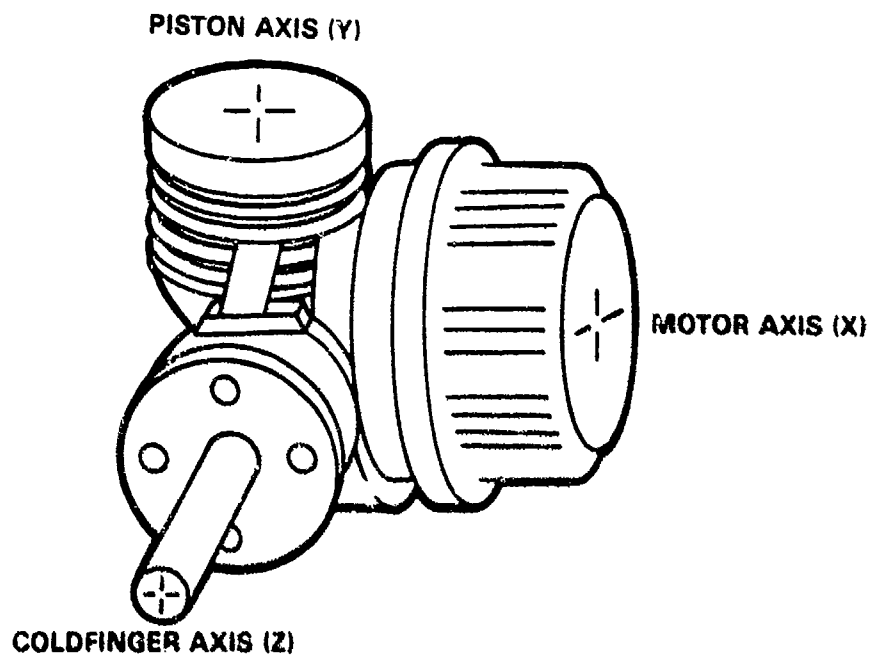
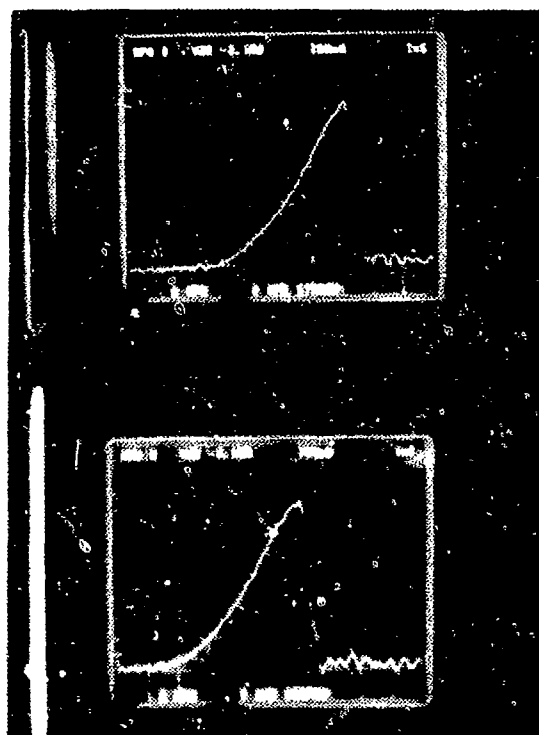
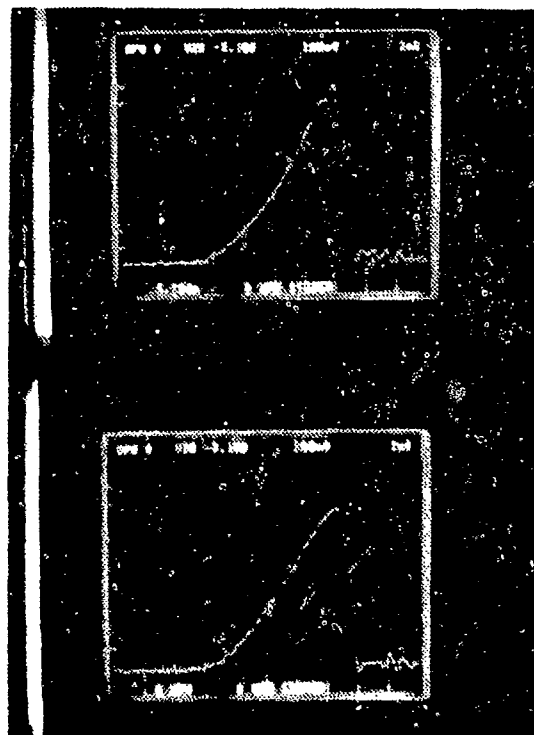


Figure 3. Cooler axes

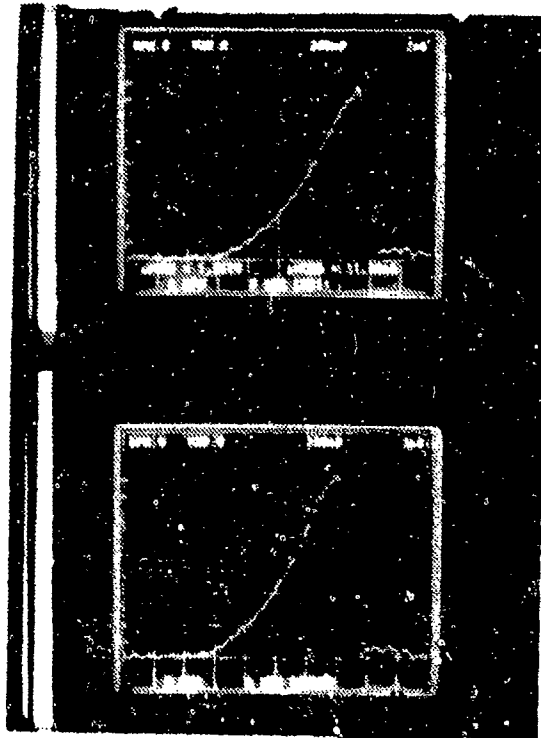




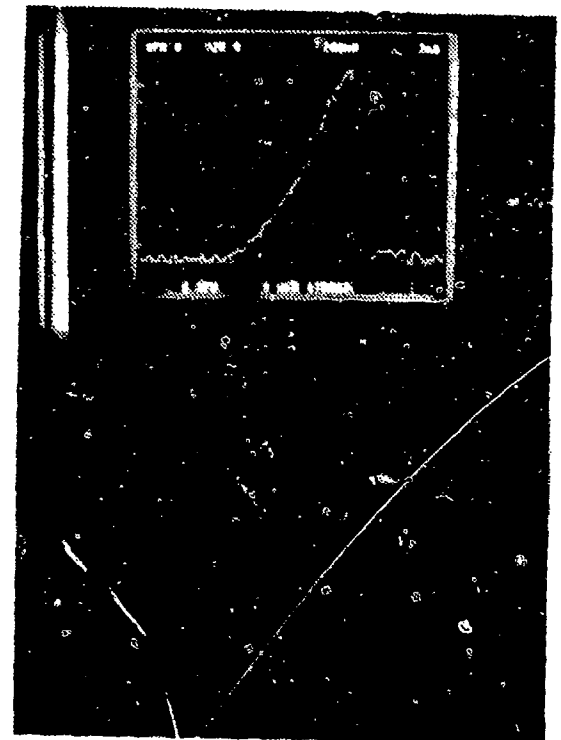
(+) COLD FINGER AXIS



(-) COLD FINGER AXIS



(+) MOTOR AXIS

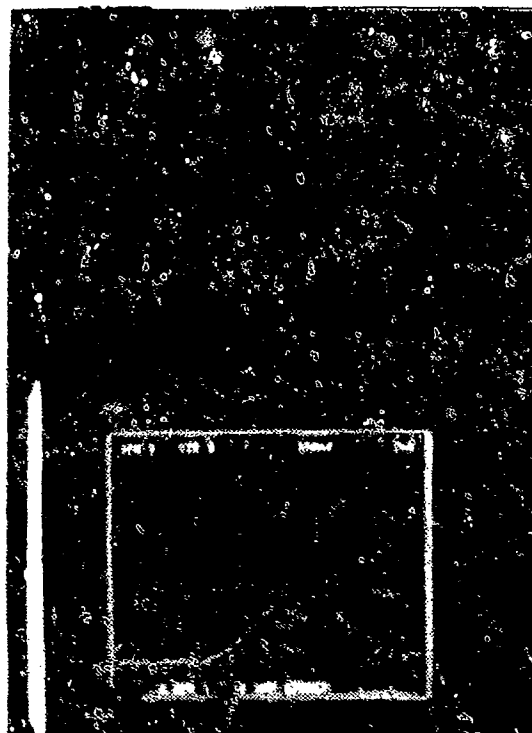


(-) MOTOR AXIS\*

\* First drop data was not recorded due to a failure in the camera.



(+) PISTON AXIS



(-) PISTON AXIS\*

- \* First drop data was not recorded due to a failure in the camera.

# NVEOL CRYOGENIC COOLER LAB

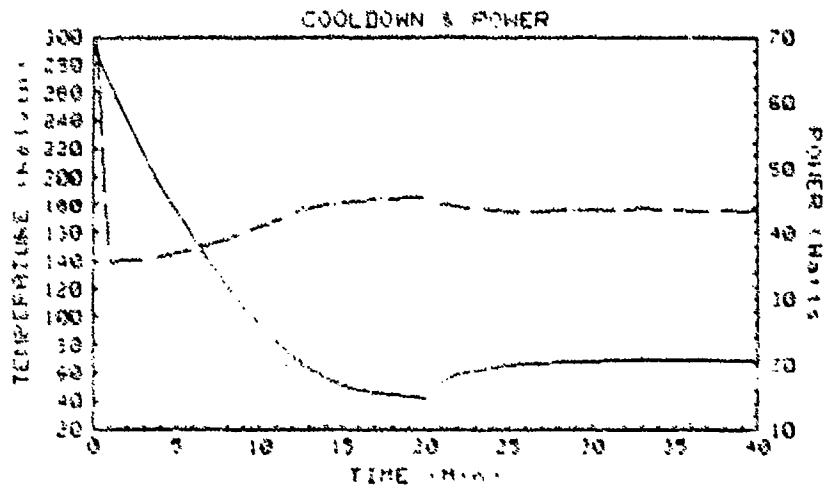
## CRYOGENIC COOLER DATA

COOLER: CTI D-0012  
 VOLTAGE: 117  
 AMBIENT: 23 (C)

DATE: 22 JULY 98 07:17  
 ENGR: HLD  
 DEWAR COMP: -2.24

TEST: PERFORMANCE TEST FOLLOWING MECHANICAL SHOCK

TIME	POWER	CURRENT	KELVIN	LOAD
0.00	30.90	.779	292.68	0.000
1.00	35.67	.433	266.96	0.000
2.00	35.90	.434	241.16	0.000
3.00	35.94	.434	217.71	0.000
4.00	36.40	.438	195.75	0.000
5.00	37.05	.441	175.35	0.000
6.00	37.60	.445	156.75	0.000
7.00	38.26	.450	139.39	0.000
8.00	39.15	.456	122.98	0.000
9.00	40.05	.462	108.10	0.000
9.60	40.59	.467	99.73	0.000
10.00	40.92	.468	94.40	0.000
11.00	41.88	.476	82.22	0.000
11.20	42.10	.478	79.68	0.000
12.00	42.91	.484	71.81	0.000
13.00	43.80	.491	62.88	0.000
14.00	44.45	.496	56.14	0.000
15.00	44.93	.500	51.31	0.000
16.00	45.23	.502	47.82	0.000
17.00	45.42	.504	45.60	0.000
18.00	45.55	.505	44.24	0.000
19.00	45.61	.506	43.24	0.000
20.00	45.73	.506	42.60	0.000
30.00	43.65	.489	68.50	.999
40.00	43.53	.499	69.57	.999



ACCEPTANCE DATA SHEET

COOLER S/N: CTI D-0012

COOLDOWN TEST

TIME REQUIRED TO REACH 100K	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 1 02 V	<u>N/A</u>	MINUTES
TIME REQUIRED TO REACH 80K	<u>N/A</u>	MINUTES
TEMPERATURE AFTER 20 MINUTES	<u>N/A</u>	K

LEAK RATE:  $3.4 \times 10^{-8}$  std cc/sec

COMMENTS: Post shock testing.  
\_\_\_\_\_  
\_\_\_\_\_

TEST TECHNICIAN G. Doggett

TEST DATE 22 JUL 88

## APPENDIX G

### VIBRATION OUTPUT

#### Self-Induced Vibration Test of CTI HD-1033D 1-Watt Integral Cooler

Two CTI HD-1033D 1-Watt Integral Coolers were tested to determine their vibration output characteristics and to compare the characteristics with those of two CTI HD-1033C 1-Watt Integral Coolers.

For these tests, each cooler was suspended from the ceiling by a bungy cord arrangement that allowed free rotation about the center of gravity and free translation. The coolers were run for approximately 15 minutes prior to making any measurements. The cooler coldfinger was covered with a styrofoam sleeve—not a detector dewar. For the piston and motor axes, an accelerometer was placed directly on the respective axis to measure the acceleration. The accelerometer for the coldfinger axis measurement was mounted on the coldfinger flange.

The linear acceleration along the coldfinger, motor, and piston axis was determined by measuring the spectrum of the resulting signal with an HP-3561A Dynamic Signal Analyzer. The force along each axis was determined by multiplying the weight of the cooler by the measured acceleration (in g's). In comparing data, the only consistent differences in translational forces between the HD-1033C and the HD-1033D was along the motor axis where the HD-1033C produced less force. This generalization was not very useful considering the sample size. All four coolers were found to be within specifications.

#### TRANSLATIONAL FORCE DATA

The data plotted on the following pages was collected from an Endevco accelerometer and signal conditioner set to output 1 volt/g. This signal was then input to the HP-3561A Dynamic Signal Analyzer and the frequency spectrum with mVrms amplitude was stored. A 1 mVrms amplitude corresponds to a 1 mgrms acceleration. The translational forces were then calculated using  $F_{\text{peak}} = (1.414) \times (W) \times (\text{grms})$  where  $W$  is equal to the weight of the cooler and grms is the maximum rms value recorded for acceleration at the 26Hz fundamental frequency or any of the next eight harmonics.

COOLERS	WEIGHT (pounds)
S/N D-0008	3.80
S/N D-0012	3.77
S/N C7064G	3.75
S/N C7045G	3.75

# TRANSLATIONAL FORCE (POUNDS)

COOLERS	AXIS		
	Coldfinger	Motor	Piston
HD-1033D			
S/N D-0008	0.16	0.27	0.20
S/N D-0012	0.14	0.21	0.15
HD-1033-C			
S/N C7064G	0.18	0.10	0.21
S/N C7045G	0.15	0.10	0.17
Specification	0.35	0.50	0.35

VIBRATION OUTPUT—S/N D-0008

STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
D0008 COLDFINGER

A: STORED

100  
mVrms

10  
mVrms  
/DIV

0

Vrms

START: 0 Hz

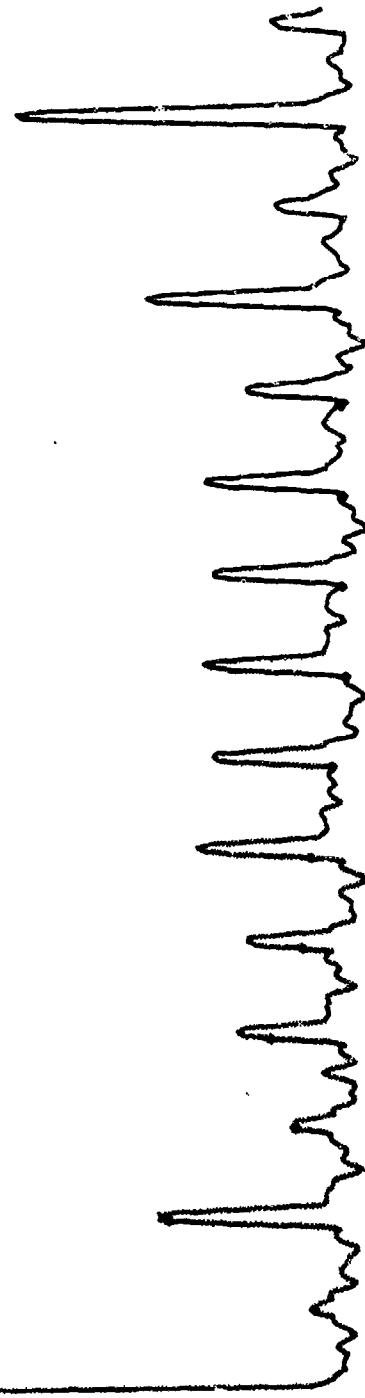
X: 53 Hz

BW: 3.8194 Hz

Y: 29.04 mVrms

STOP: 400 Hz

THD: 36.4 %

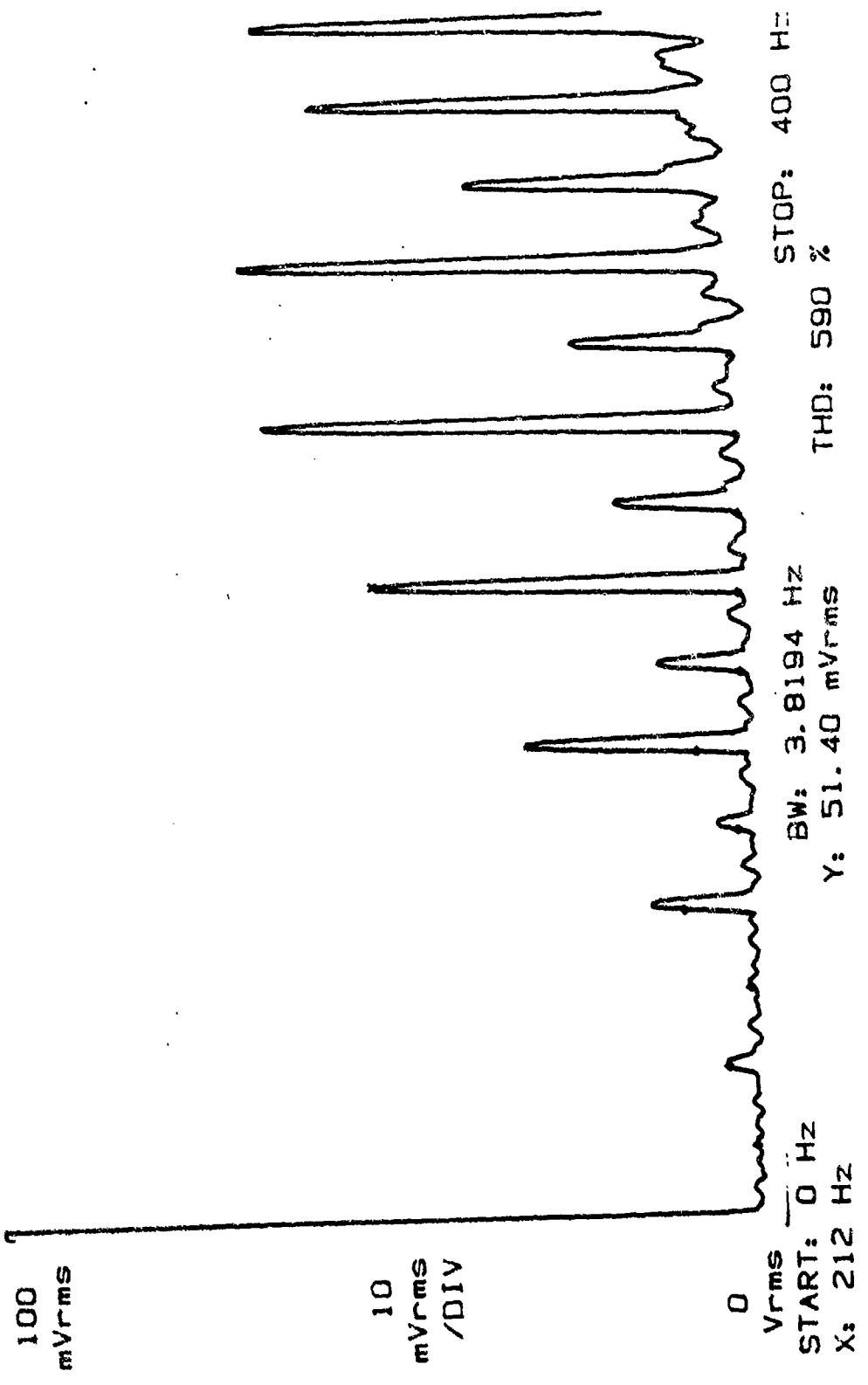




STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
D00008 MOTOR

A: STORED



STATUS: PAUSED  
RMS: 20

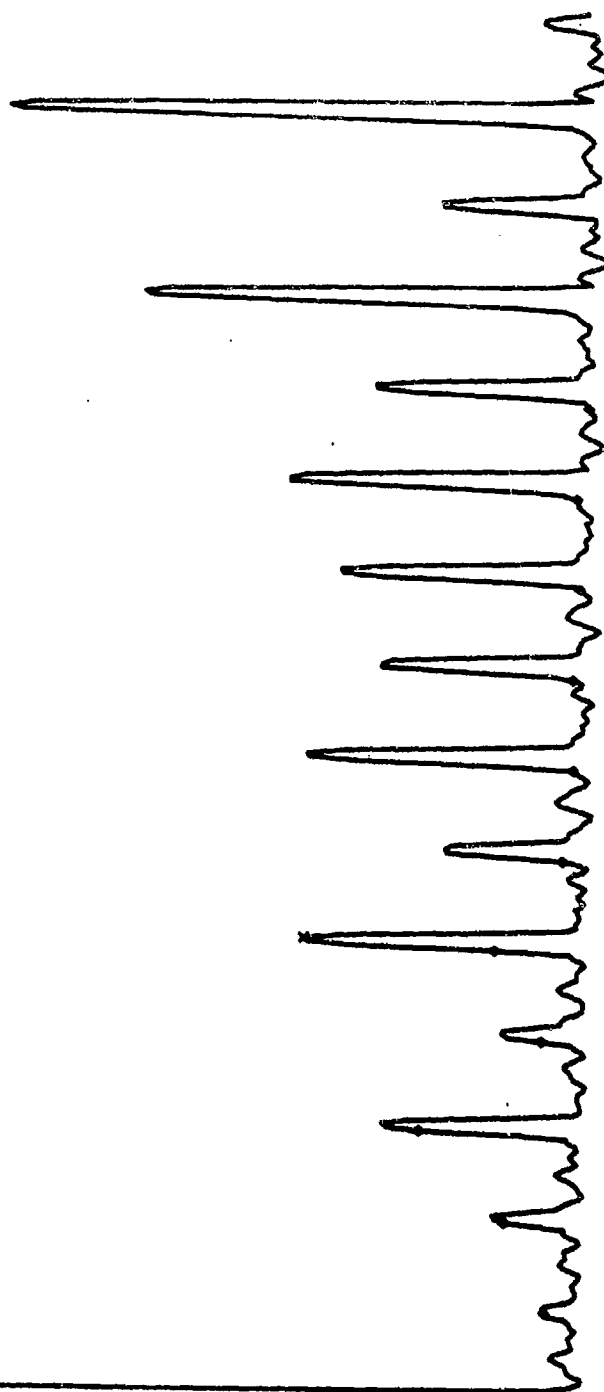
RANGE: -20 dBV  
D0008 PISTON

A: STORED

100  
mVrms

10  
mVrms  
/DIV

0  
Vrms



START: 0 Hz  
X: 133 Hz

BW: 3.8194 Hz  
Y: 38.17 mVrms

THD: 389 %  
STOP: 400 Hz

# VIBRATION OUTPUT—S/N D-0012

STATUS: PAUSED  
RMS: 20

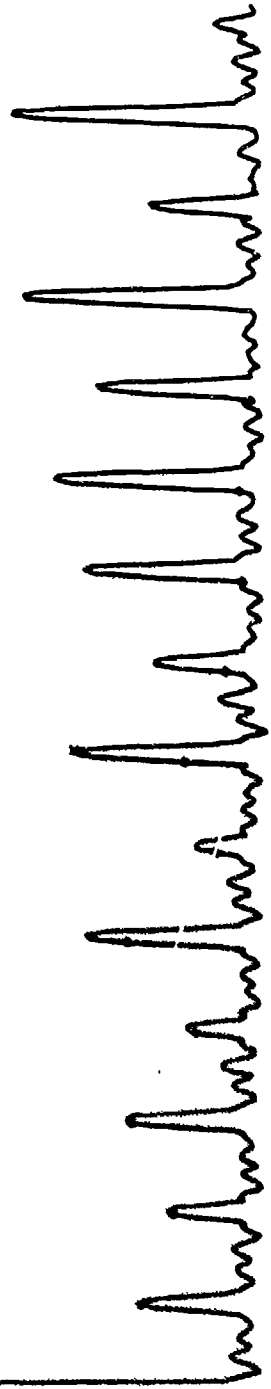
RANGE: 23 dBV  
D0012 COLDFINGER

A: MAG

100  
mVrms

10  
mVrms  
201V

0  
Vrms



START: 0 Hz  
X: 185 Hz

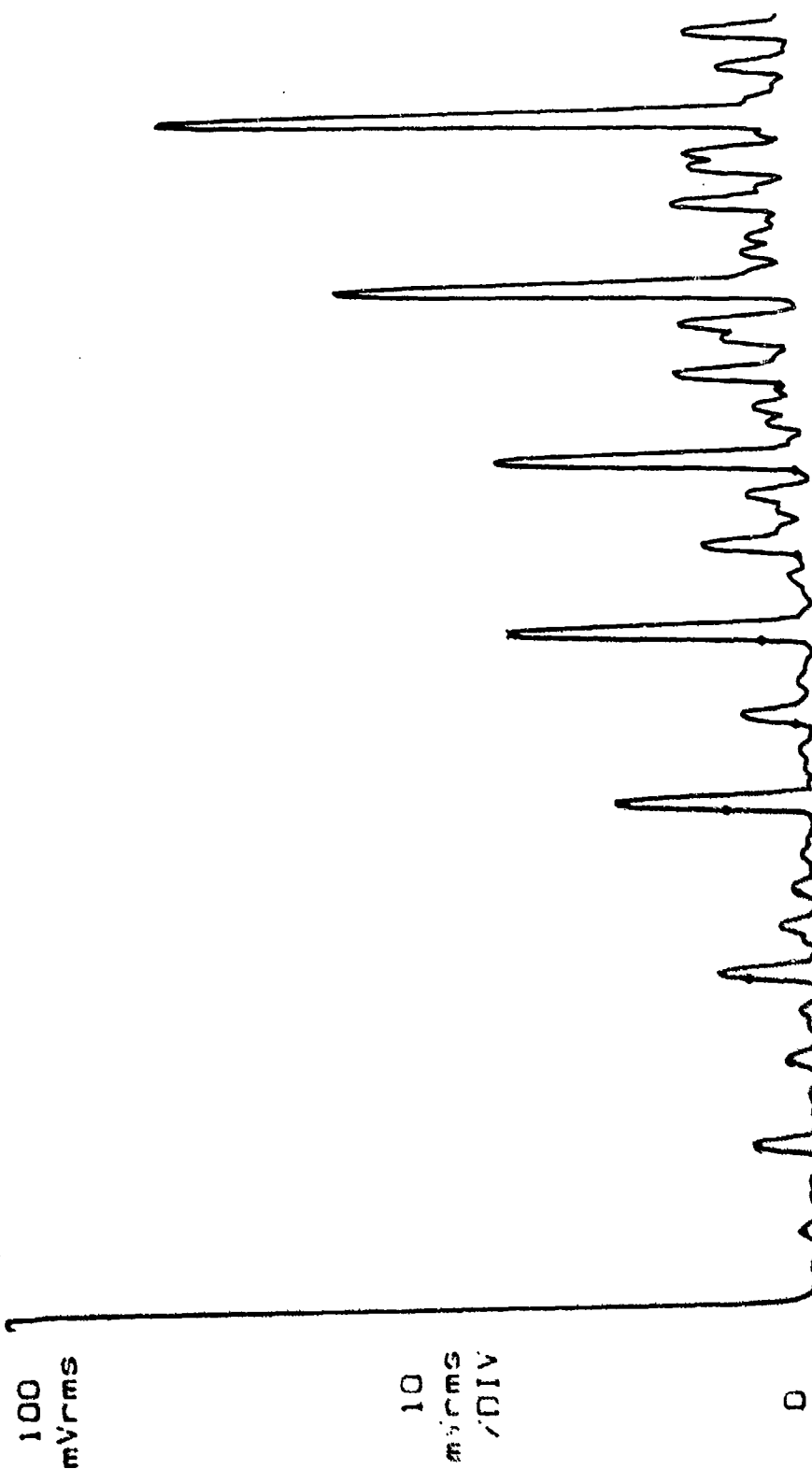
BW: 3.8194 Hz  
Y: 25.60 mVrms

THD: 224 %  
STOP: 400 Hz

STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
D0012 MOTOR

A: STORED



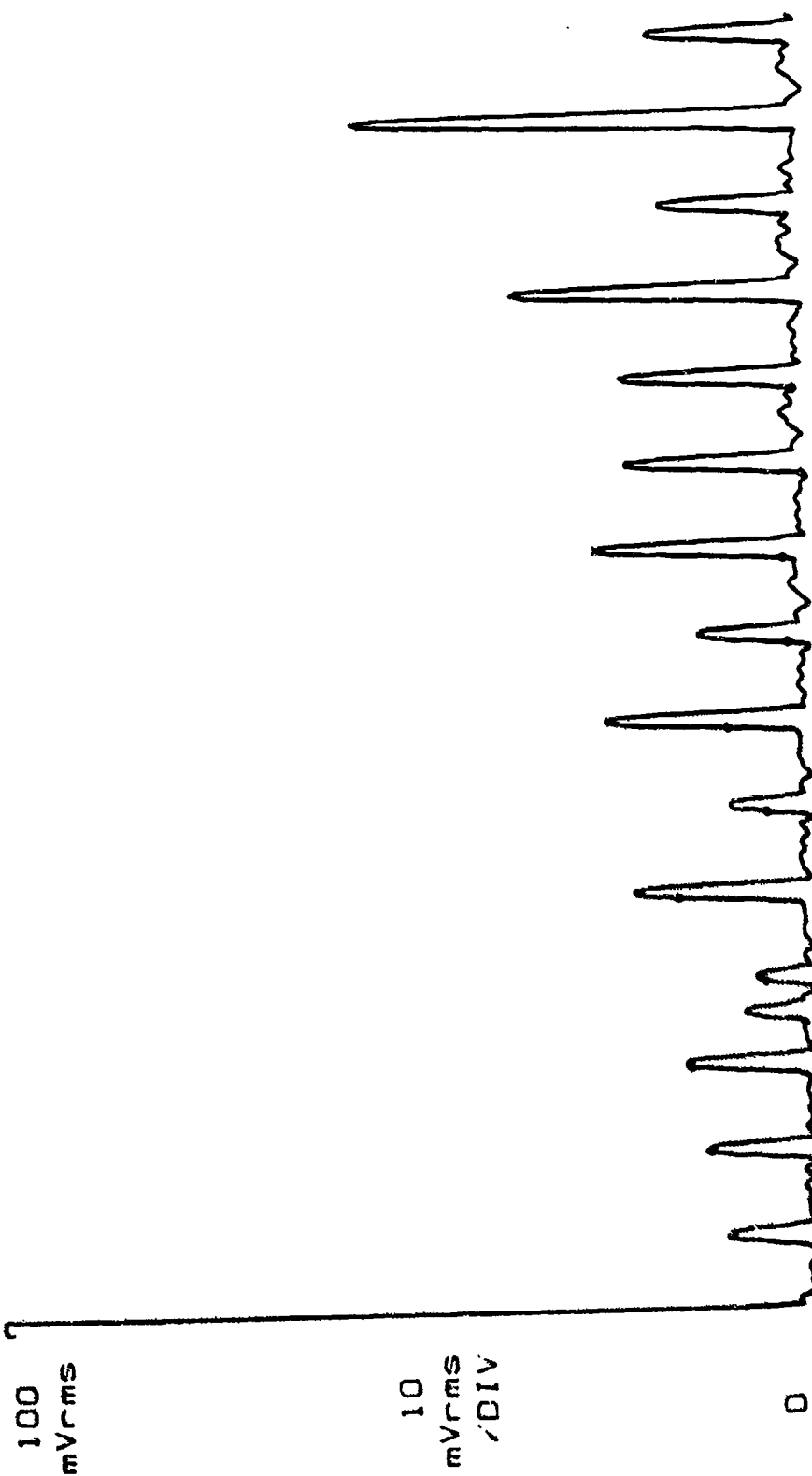
START: 0 Hz  
STOP: 400 Hz  
THD: 48%

BW: 3.8194 Hz  
Y: 38.79 mVrms

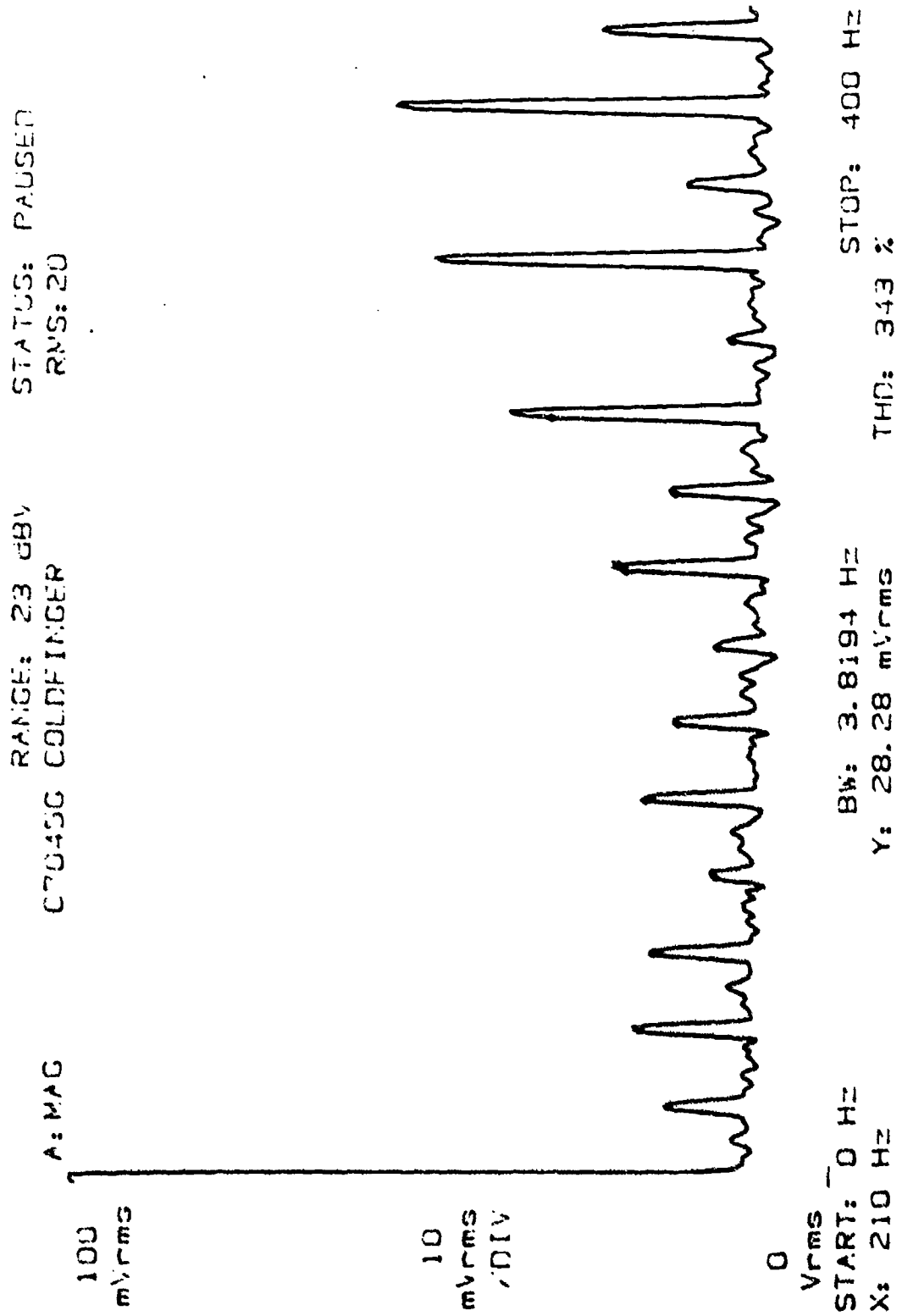
STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
00012 PISTON

A: STORED



# VIBRATION OUTPUT—S/N C7045G



STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
C70450 MOTOR

A: STORED

100  
mVrms

10  
mVrms  
2DIV

0  
Vrms

START: 0 Hz  
X: 183 Hz

BW: 3.8194 Hz  
Y: 18.08 mVrms

THD: 518 %  
STOP: 400 Hz



STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
C7045G PISTON

A: STORED

100  
mVrms

10  
mVrms  
DIV

0

Vrms

START: 0 Hz

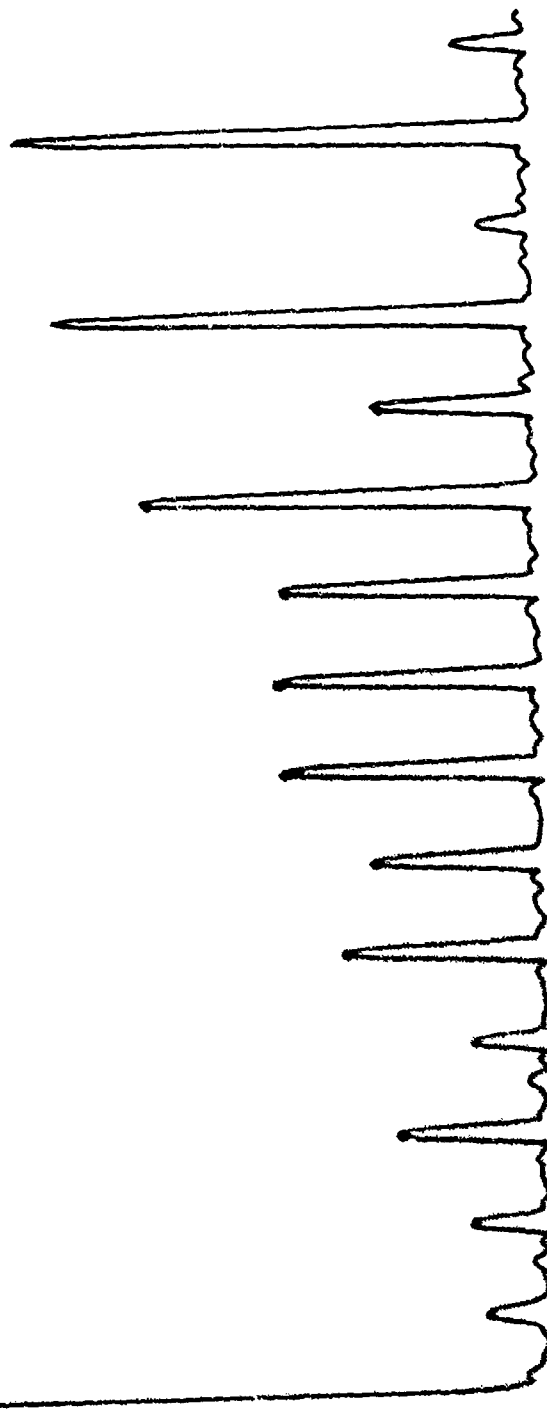
X: 208 Hz

BW: 3.8194 Hz

Y: 33.29 mVrms

STOP: 400 Hz

THD: 789 %



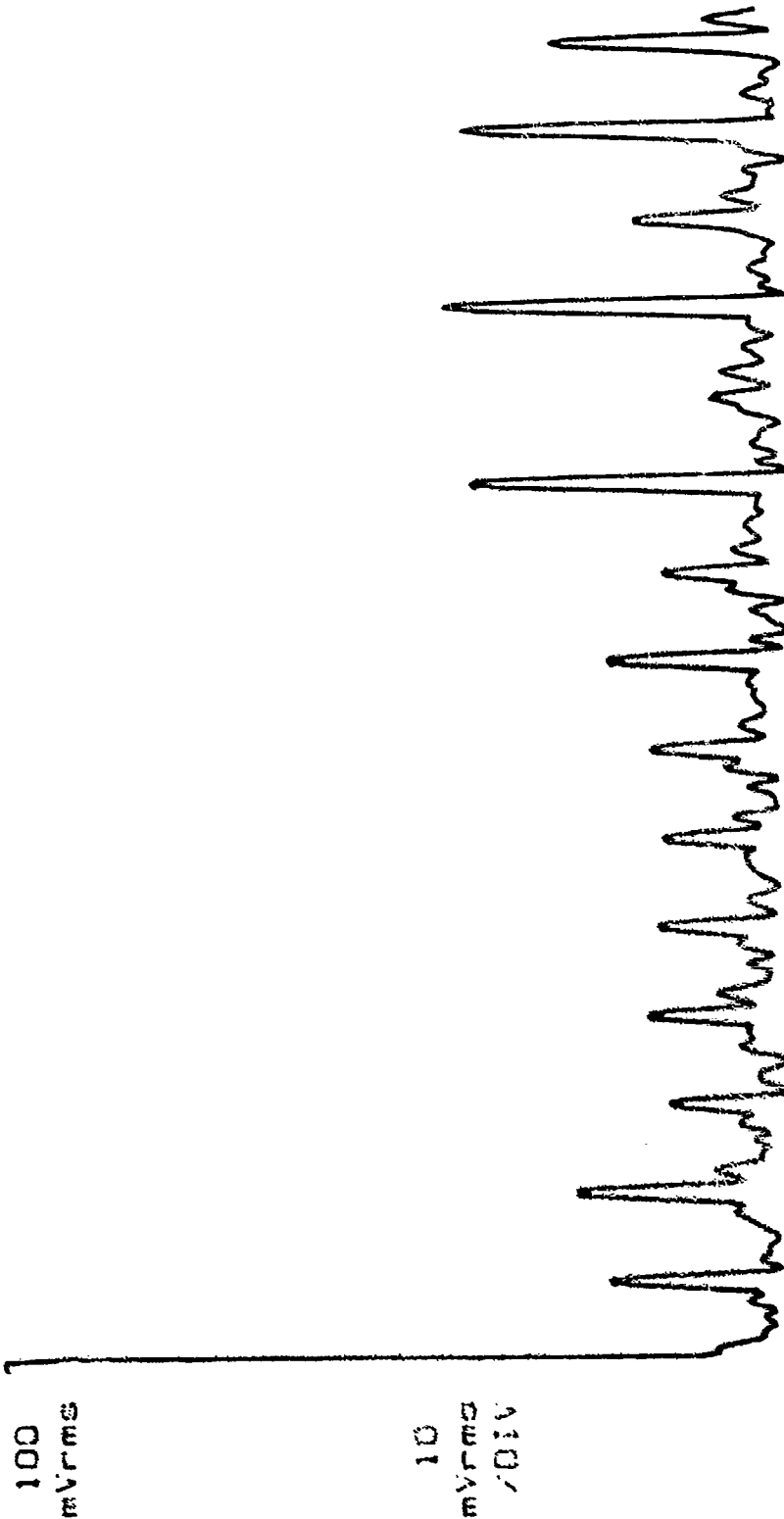


# VIBRATION OUTPUT--S/N C7064G

STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
C7064 COLDFINGER

A: STORED



0  
Vrms  
START: 0 Hz  
X: 52 Hz  
BW: 3.8194 Hz  
Y: 34.32 mVrms  
THD: 299 %  
STOP: 400 Hz

STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
C7064G MOTOR

A: STORED

100  
mVrms

10  
mVrms  
/DIV

0  
Vrms

START: 0 Hz  
X: 52 Hz

BW: 3.8194 Hz  
Y: 18.59 mVrms

THD: 685 %  
STOP: 400 Hz



STATUS: PAUSED  
RMS: 20

RANGE: -20 dBV  
C7064C PISTON

A: STORED

100  
mVrms

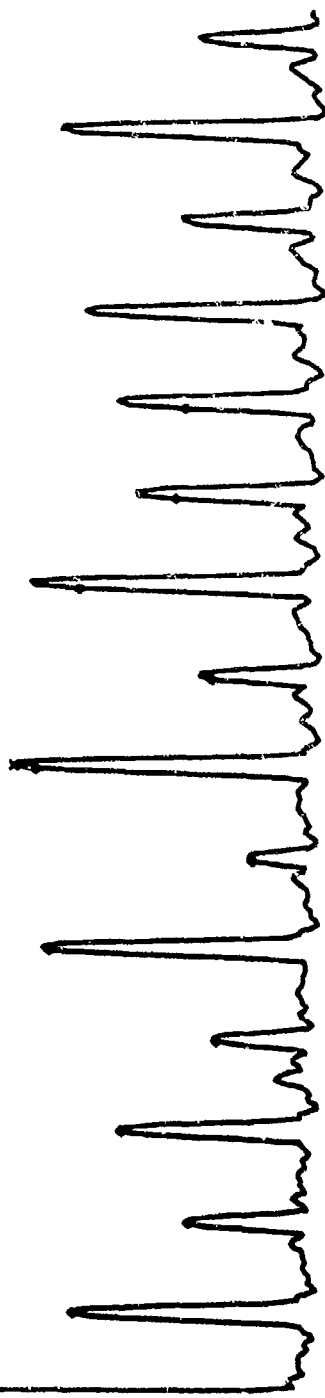
10  
mVrms  
/DIV

0  
Vrms

START: 0 Hz  
X: 183 Hz

BW: 3.8194 Hz  
Y: 39.42 mVrms

THD: 247 %  
STOP: 400 Hz



APPENDIX H  
PURCHASE DESCRIPTION (PD) 0182-001 (CR), 9/26/86


PD-0182-001(CR)  
26 September 1986

PURCHASE DESCRIPTION

COOLER, CRYOGENIC LONG LIFE, ONE WATT INTEGRAL


This Document May Be Used for a Purchase Description  
for This Procurement Only.

APPROVAL:

  
PROJECT LEADER  
COOLER, CRYOGENIC LONG LIFE,  
ONE WATT INTEGRAL

  
CONFIGURATION MANAGER  
CECOM CENTER FOR NIGHT  
VISION AND ELECTRO-OPTICS CENTER

REVIEWED BY:

  
DIRECTOR  
CECOM, PA&T DIRECTORATE  
ELECT/PMDE DIVISION  
NIGHT VISION EOC BRANCH

## PURCHASE DESCRIPTION

### COOLER, CRYOGENIC LONG LIFE, ONE WATT INTEGRAL

This Purchase Description is approved for use by USACECOM, Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This Purchase Description covers one type of common module; one watt integral cryogenic cooler built with clearance seals.

#### 2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this purchase description to the extent specified herein.

#### SPECIFICATIONS

##### MILITARY

MIL-P-116	- Preservation-Packaging, Methods of
MIL-P-11268	- Parts, Materials, and Processes Used in Electronic Equipment
MIL-E-55585	- Electronic Equipment and Parts, Packaging of

#### STANDARDS

##### MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-252	- Classification of Visual and Mechanical Defects for Equipment, Electronic, Wired, and Other Devices
MIL-STD-454	- Standard General Requirements for Electronic Equipment
MIL-STD-726	- Packaging Requirement Codes
MIL-STD-810C	- Environmental Test Methods

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Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: HQ, USA Communications - Electronics Command and Fort Monmouth, ATTN: AMSEL-ED-TO, Fort Monmouth, NJ 07703 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FSC 5855

DRAWINGS

USA ELECTRONICS R&D COMMAND

SM-D-773447

- Outline Dimension. Cooler. Cryogenic, Mechanical

54490-5004372

- Cryogenic Heat Load Assembly (1 Watt Integral)

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this purchase description to the extent specified herein. Unless otherwise indicated the issue in effect on the date of invitation for bids or request for proposal shall apply.

ANSI S1.11-1971

- Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets

(Application for copies of ANSI standards should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

3. REQUIREMENTS

3.1 Description. The Cooler, Cryogenic, Long Life, One Watt Integral, referred to herein as the cooler, is a closed-cycle refrigerator for cooling the infrared detector and interfacing with the Dewar of the infrared Detector-Dewar package in an infrared system. The cooler is identical in performance and external configuration as the HD-1033B/UA and HD-1033C/UA. In system usage they are completely interchangeable.

3.2 Construction. The cooler shall be constructed in accordance with the outline dimension drawing of SM-D-773447 and as specified herein.

3.2.1 Weight. The weight of the cooler shall be 3.7. (+0.2, -0.2) pounds.

3.3 First article. The contractor shall furnish first article assemblies in accordance with 4.3.

3.4 Materials, parts, and processes. Materials, parts, and processes shall be as specified herein and as shown on the applicable drawings. Materials, parts, and processes not specified shall be selected by the contractor in accordance with MIL-P-11268.

3.5 Components. The cooler shall consist of an ac motor-driven, helium-filled compressor with a coldfinger.

3.6 Performance characteristics. The cooler shall meet the performance characteristics specified herein when adequate heat sinking or convective cooling is provided to ensure that any point on the cooler cylinder head shall fall within 5°C to 15°C above ambient air temperature.

3.6.1 Cooling capacity. The cooler with thermal load (copper mass) shall provide the minimum refrigeration capacity at 80 K maximum as shown in Figure 1, curve A.

3.6.2 Cooldown time. The cooldown time to reach a cold tip temperature of 80 K with a 1440, (+25, -0) joule copper thermal mass (in accordance with Drawing 54490-5004372) (from 300 K to 80 K) shall be in accordance with figure 2.

3.6.3 Input power. The total input power to the cooler shall not exceed that shown in figure 3 with 1440, (+25, -0) joule thermal mass and at a coldfinger temperature of 80 (+0, -20) K with the heat load shown in figure 1, curve A as a minimum. The input voltage shall be 117,  $\pm 2$  volts alternating current (VAC), 400,  $\pm 20$  hertz (Hz) power source.

3.6.4 Acoustic noise. The cooler noise emission shall not be more than the values listed below, when measured at a distance of 3 feet.

Sound pressure values		
Center frequency (Hz)	Octave band (Hz)	Maximum sound pressure level (dB). reference 0.0002 microbar
125	87-175	45
250	175-350	45
500	350-700	48
1000	700-1400	55
2000	1400-2800	60
4000	2800-5600	65
8000	5600-11200	67

3.6.5 Leak rate. The leak rate of the cooler shall not be greater than  $2.5 \times 10^{-6}$  cubic centimeters per second (cc/sec) helium equivalent at an ambient temperature of +23°C,  $\pm 5^\circ\text{C}$ .

3.6.6 Vibration output. The maximum amplitude, at the ambient temperature of +23°C,  $\pm 5^\circ\text{C}$ , of the vibrational force induced by the cooler at a frequency of 26,  $\pm 4$  Hz or any of the next eight harmonics along the compressor piston and coldfinger axes shall not exceed 0.35 pound (semi-amplitude) and shall not exceed 0.5 pound (semi-amplitude) along the motor axis. The maximum amplitude of the torque induced by the cooler about the motor, piston and coldfinger axes at 26,  $\pm 4$  Hz or any of the next eight harmonics shall not exceed:

- a. 4.0 in-oz (semi-amplitude) compressor piston axis
- b. 4.0 in-oz (semi-amplitude) coldfinger axis
- c. 15.0 in-oz (semi-amplitude) motor axis.

3.6.7 Restart. The cooler shall restart after having cooled to the operating temperature of at least 80K at any ambient from -54°C to +71°C.

3.7 Environmental conditions.

3.7.1 Temperature shock. The cooler shall not be damaged (see 6.3.1) by sudden changes in temperature between -62°C and +95°C.

3.7.2 High temperature. The cooler shall not be damaged by storage to +95°C or operation up to +71°C.

3.7.3 Low temperature. The cooler shall not be damaged by operation to -54°C or storage to -62°C.

3.7.4 Shock. The cooler shall not be damaged by high intensity shocks of 100 g's peak amplitude with 11 milliseconds duration and by bench handling tests.

3.7.5 Vibration. The cooler shall not be damaged by vibration over a frequency spectrum at the specified g levels and amplitudes shown in figure 4.

3.8 Burn-in. Each cooler delivered shall have accumulated a minimum of 12 hours burn-in over the temperature profile in accordance with figure 5.

3.9 Reliability. The cooler shall have a lower mean-time-to failure (MTTF) (See 6.3.3) of at least 2,500 hours.

3.10 Treatment. Unless otherwise specified, the cooler and its components and parts shall be cleaned and treated in accordance with the applicable drawing.

3.11 Nameplates and product marking. Unless otherwise specified, the cooler, parts, components, subassemblies, and assemblies thereof shall be marked for identification and reference designation markings in accordance with the applicable drawing.

3.12 Workmanship. Workmanship shall be in accordance with MIL-STD-454, Requirement 9.



## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. Inspections shall be classified as follows:

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.5).
- c. Inspection of packaging (see 4.10).

4.3 First article inspection. Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.3.1 Inspections. All materials, parts, processes and assemblies shall be examined for conformance to the applicable specification or drawing. Inspections shall be made using MIL-STD-105, General Inspection Level II with a 2.5 percent AQL for mechanical and a 4 percent AQL for visual inspection, except as noted in table I.

TABLE I. Inspections.

Inspection Requirement	Percent AQL	Requirement paragraph	Inspection criteria
Any part or component missing or damaged	2.5	3.2, 3.4	MIL-STD-252
Weight not as specified	2.5	3.2.1	MIL-STD-252
Treatment not as specified	2.5 1/	3.10	
Marking not as specified	2.5	3.11	
Workmanship not as specified	2.5	3.12	MIL-STD-454
Dimensions not as specified		3.2	SM-D-773447

1/ MIL-STD-105, Inspection Level S-3 or objective quality evidence.

4.3.2 Test. Upon successful completion of the inspections specified in 4.3.1, four first article coolers shall be subjected to reliability testing and 2 first article coolers shall be subjected to all other tests listed in table II. Tests may be conducted in any order. Failure of any test shall constitute first article failure.

4.3.3 Disposition of first article samples. First article samples shall not be considered as part of the procurement quantities (see 6.2.f).

TABLE II. First article inspection.

Inspection	Requirement paragraph	Test paragraph
Cooling capacity	3.6.1	4.6.1
Cooldown time	3.6.2	4.6.2
Input power	3.6.3	4.6.3
Acoustic noise	3.6.4	4.6.4
Leak rate	3.6.5	4.6.5
Vibration output	3.6.6	4.6.6
Restart	3.6.7	4.6.7
Temperature shock	3.7.1	4.7.1
High temperature	3.7.2	4.7.2
Low temperature	3.7.3	4.7.3
Shock	3.7.4	4.7.4
Vibration	3.7.5	4.7.5
Reliability	3.9	4.9

4.4 Inspection procedures for quality assurance provisions. Unless otherwise specified herein, the cooler shall be operated at an ambient temperature of +23°C, +50°C. Adequate heat sinking or convective cooling shall be provided to ensure that any point on the cooler cylinder head shall fall within 50°C to 150°C above ambient air temperature (see 3.6).

#### 4.5 Quality conformance inspection.

4.5.1 Inspection. Inspection shall be as specified in 4.3.1.

#### 4.5.2 Tests.

4.5.2.1. Burn-in. Burn-in shall be in accordance with 4.8 and shall be performed upon each cooler that has passed the inspection of 4.5.1.

4.5.2.2 Group A inspection. Group A inspection shall be conducted on all coolers which have completed burn-in specified in 4.5.2.1. Group A tests listed in table III may be performed in any order unless otherwise specified. Failure of any test shall be cause for rejection of that unit.

TABLE III. Group A inspection.

Inspection	Requirement paragraph	Test paragraph
Cooling capacity	3.6.1	4.6.1
Cooldown time	3.6.2	4.6.2
Input power	3.6.3	4.6.3
Leak rate	3.6.5	4.6.5
Restart	3.6.7	4.6.7

4.5.2.3 Group B inspection. Not required.

4.5.2.4 Group C inspection. Group C inspections shall be conducted on coolers selected from units which have passed the tests in 4.5.2.2 (see 6.2.h). The sample(s) shall be tested in accordance with the inspections listed in table IV. Samples shall be selected in accordance with 4.5.2.4.1. Group C tests listed in table IV may be performed in any order.

4.5.2.4.1 Sampling for Group C inspection. One Group C sample shall be randomly selected from the initial delivery quantity and one sample selected from every 150 units thereafter.

TABLE IV. Group C inspection.

Inspection	Requirement paragraph	Test paragraph
Acoustic noise	3.6.4	4.6.4
Vibration output	3.6.6	4.6.6
Temperature shock	3.7.1	4.7.1
High temperature	3.7.2	4.7.2
Low temperature	3.7.3	4.7.3

4.5.2.4.2 Group C failures. Actions required relative to Group C failures shall be specified in the contract (see 6.2.c.(2)).

4.5.2.4.3 Disposition of Group C samples. Group C samples shall be accepted on contract subsequent to successful Group A retest.

4.5.2.5 Group D inspection. Group D inspections shall be conducted on coolers selected from units which have passed the tests in 4.5.2.2. The samples shall be tested in accordance with 4.9.

4.5.2.5.1 Sampling for Group D inspection. The sample shall be randomly selected from the production quantity such that the results of the test will be obtained prior to delivery of 75 percent of the total quantity.

4.5.2.5.2 Group D Failures. Actions required relative to group D failures shall be specified in the contract (see 6.2.c.(3)).

4.5.2.5.3 Disposition of Group D Samples. Group D samples shall not be considered as part of the procurement quantities (see 6.2.f).

#### 4.6 Test methods.

4.6.1 Cooling capacity. The cooling capacity shall be measured by attaching to the cooler a test Dewar and coldstation. The heat load shall be applied after achieving cooldown. Capacity shall be measured not less than 30 minutes later. The tests of paragraphs 4.6.1, 4.6.2 and 4.6.3 shall be performed using test equipment consisting of the following items to measure cooldown and refrigeration capacity:

1. Test dewar
  2. Coldstation
  3. Appropriate power supplies and meters
  4. High vacuum source
- a. The test dewar shall be made of either brass or aluminum with a highly polished surface finish of at least an 8 RMS. The test dewar in conjunction with the high vacuum source shall enclose the coldfinger and coldstation in a vacuum of  $1 \times 10^{-5}$  torr or lower.
  - b. The 1440 joule coldstation shall consist of the following elements as defined on drawing 54490 5004372: copper block, temperature sensor, resistor, thermally conductive epoxy and a clamp screw.
  - c. The coldstation assembly will have the following characteristics:
    1. The temperature sensor and resistor will be bonded to the copper block with the thermally conductive epoxy.
    2. The thermal energy which must be removed when cooling the coldstation from 300 K to 80 K shall be 1440, (+25, -0) joules. The mass of the coldstation shall be adjusted until it meets this requirement.

3. The resistor in the coldstation shall have a voltage applied to obtain a 1000, (+20, -0) mw thermal load. The applied voltage shall be such that the product of the voltage and the current of the resistor shall equal 1000, (+20, -0) mw.
4. The resistor and temperature sensor shall be connected to a vacuum feedthru by four teflon coated constantan wires. The wires shall be less than six inches in length and the resistance shall be less than one percent of the value of the resistor in the coldstation.
5. The coldstation is clamped to the coldfinger, sufficiently tight to effect good heat transfer without damaging the coldfinger.
6. Good thermal conductivity is assured by applying a metal oxide impregnated silicone thermal joint compound to the end of the coldfinger that is in contact with the coldstation.
7. A radiation shield shall not be used.

4.6.2 Cooldown time. Cooldown time shall be measured using the test Dewar and the copper mass described in 4.6.1. Failure to meet requirements of 3.6.2 shall constitute failure of this test.

4.6.3 Input power. Input power shall be measured at a coldfinger temperature no higher than 80 K. Failure to meet requirements of 3.6.3 shall constitute failure of this test.

4.6.4 Acoustic noise. The cooler shall be set up for operation in an area where the background noise level is at least 5 dB below the sound level to be measured. The cooler shall be operated and sound pressure measurements made with the cooler oriented in 4 positions in the same plane with each position approximately 90 degrees apart. Measurements shall be made with an octave-band analyzer with characteristics which comply with ANSI Specification S1.11-1971. The test shall be performed without using a test Dewar. Failure to meet requirements of 3.6.4 shall constitute failure of this test.

4.6.5 Leak rate. The cooler shall be placed in a bell jar or suitable fixture connected to a helium mass spectrometer. The bell jar or fixture shall be evacuated to establish an inside-out test mode. Operating test shall not be performed during leak rate test. The leakage rate shall be measured at +23°C, +5°C ambient. Failure to meet requirements of 3.6.5 shall constitute failure of this test.

4.6.6 Vibration output. The cooler shall be turned on for 15 minutes to allow it to reach equilibrium temperature. The cooler shall be vertically suspended such that the fundamental frequency of the cooler is much higher than the natural frequency of the suspension system. The static deflection of this arrangement shall be in excess of 6 inches and critical frequency ( $f_{cr}$ ) of 1.3 Hz approximately. The acceleration along each axis shall be obtained by attaching

an accelerometer to the center of the piston and motor faces and to the unit centered on the coldfinger axis. Moments around each axis shall be obtained by attaching two accelerometers (to the motor, piston face or coldfinger face) and coherently subtracting the two signals. This difference divided by the separation distance between the accelerometers yields the angular acceleration. Moment of inertia shall be obtained from the period of a bifilar pendulum containing the cooler. Peak forces are derived from the expression  $F = MA$ , where  $F$  is the peak force,  $M$  is the cooler mass, and  $A$  is the measured acceleration at a given frequency. Peak torque is derived from the expression  $T = I\alpha$ , where  $T$  is the peak torque,  $I$  is the moment of inertia about the principal axis, and  $\alpha$  is the measured angular acceleration for the applicable axis at a given frequency. The test shall be performed without using a test Dewar. Failure to meet requirements of 3.6.6 shall constitute failure of this test.

**4.6.7 Restart.** The cooler shall be operating at 80K or less in a  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$  ambient. The power switch shall be turned off and the cooler motor shall be at rest. The power switch shall be turned on and the cooler must start within 5 seconds. This test shall be repeated a total of five times. The cooler shall also be tested at  $-54^{\circ}\text{C}$  and  $+71^{\circ}\text{C}$  using the above procedure during the high and low tests of 4.7. The restart test shall be performed after the cool down and cooling capacity test. Failure to meet the requirement of 3.6.7 shall constitute failure of this test.

**4.7 Environmental tests.** Unless otherwise specified, the environmental tests shall be performed in accordance with MIL-STD-810. The operating tests required before and after environmental tests shall be those specified in table III. During 4.7.2 and 4.7.3, operating test 4.6.1, 4.6.2 and 4.6.3 shall be performed and must be successfully completed. Operating tests are not required during 4.7.1, 4.7.4 and 4.7.5 except that the unit under test shall have power applied during 4.7.4 (Procedure IV only) and 4.7.5.

**4.7.1 Temperature shock.** The cooler shall be tested in accordance with MIL-STD-810, Method 503.1, Procedure I except that the temperature of step 2 shall be  $-62^{\circ}\text{C}$  and the temperature of step 1 and step 4 shall be  $+95^{\circ}\text{C}$ . Failure to meet requirements of 3.7.1 shall constitute failure of this test.

**4.7.2 High temperature.** The cooler shall be tested in accordance with MIL-STD-810, Method 501.1, Procedure I (see figure 6) except that the temperature of step 2 shall be  $+95^{\circ}\text{C}$ . The temperature of steps 4 and 5 shall be  $+71^{\circ}\text{C}$ . Failure to meet requirements of 3.7.2 shall constitute failure of this test.

**4.7.3 Low temperature.** The cooler shall be tested in accordance with MIL-STD-810, Method 502.1, Procedure I (see figure 7) except that the storage temperature of step 2 shall be  $-62^{\circ}\text{C}$  and low operating temperature of step 4 shall be  $-54^{\circ}\text{C}$ . Failure to meet requirements of 3.7.3 shall constitute failure of this test.

4.7.4 Shock. The cooler shall be tested in accordance with MIL-STD-810, Method 516.2, Procedure IV, figure 516.2-1 (100 g's peak value at 11 milli-seconds time duration) and Procedure V. Failure to meet requirements of 3.7.4 shall constitute failure of this test.

4.7.5 Vibration. The cooler shall be tested in accordance with MIL-STD-810, Method 514.2, Procedure VIII except that the curve shown in figure 4 of this specification shall be used in lieu of the MIL-STD-810 curve. The sinusoidal cycle time shall be 120 minutes per axis. The dwell time shall be 1/6 of the cycling time at each resonance. Failure to meet requirements of 3.7.5 shall constitute failure of this test.

4.8 Burn-in. Each cooler shall be subjected to a minimum of 12 hours burn-in in accordance with figure 5. Failure of burn-in shall be defined as failure to pass the inspections listed in table III after burn-in. Any unit which fails and is repaired or is later altered, repaired or reworked, shall be resubjected to burn-in.

#### 4.9 Reliability.

4.9.1 Reliability. The lower MTF shall be demonstrated using 4 coolers in accordance with the reliability test cycle shown in figure 8. Heat load, input power, cold tip temperature and ambient temperature shall be monitored hourly. Cooldown time shall be measured twice during each cycle of figure 8, at -32°C and +52°C. The tests of paragraph 4.9.1.1 shall be performed at least once prior to and once after the reliability test. The results of all 4.9.1.1 tests shall be used to determine the success or failure of the reliability test.

4.9.1.1 Failure definition. Failure shall be defined by any one of the four criteria below:

- a. Inability to achieve the heat load carrying capability in accordance with figure 1, curve C at any ambient measured at 90 K when measured at any point during the 40-hour reliability cycle.
- b. Failure to cooldown to 90K in 15 minutes.
- c. Failure to meet 55 watts input power when measured at any point during the 40-hour reliability cycle.
- d. Failure to meet the leak rate requirement of 3.6.5.

Should a failure occur in one of the four categories above, the hours accumulated since completion of the previously successful test, shall not be included in the accept/reject decision.

4.9.1.2 Accept/Reject decision. The accept/reject decision shall be made by the Government in accordance with the following definition. Four coolers shall be run until 10,000 total "on" hours have been accumulated. A cooler which experiences a relevant failure as determined by the Government shall not be repaired and put back into test. No single unit "on" time shall be less than  $\frac{1}{4}$  the average operating time of all units on test and no single unit "on" time shall be greater than 1.25 the average operating time of all units on test.

4.10 Inspection of packaging. Packaging shall be inspected in accordance with MIL-P-116 to determine compliance with requirements of section 5.

## 5. PACKAGING

5.1 Preservation. Preservation shall be as specified in MIL-STD-726, coded as follows:

5.1.1 Level A. 10-1-1-00-NS-X-ED-0-00-A.

5.1.2 Level B. 10-1-1-00-NS-X-ED-0-00-B.

5.2 Packing and marking. Packing and marking shall be in accordance with MIL-E-55005.

## 6. NOTES

6.1 Intended use. The cooler is intended for use in infrared systems.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. First article tests are required except for existing suppliers (6.3.2).

1. Time frame for submission of first article test reports when first article tests are required.

2. Time frame for approval of first article test reports when first article tests are required.

c. Production delivery schedule.

1. Defined in terms of monthly lots.

2. Actions required relative to group C failures (see 4.5.2.4.2).

3. Actions required relative to group D failures (see 4.5.2.5.2).



- d. Level A or level B preservation and packaging (the coldfinger is extremely delicate; packaging shall protect it from bending or distortion)(see section 5).
- e. MIL-STD-810C shall be used for environmental tests of 4.7.
- f. Deliver all first article samples to - Commander. USACECOM, ATTN: AMSEL-NV-EST, Fort Belvoir, VA 22060.
- g. Environmental pollution prevention measures are contained in the packaging material specifications referenced herein. Refer to material specification or preparing activity for recommended disposability methods.
- h. Group C and Group D inspection monthly sample size to be established based on cumulative totals of concurrent contract.
- i. All coolers delivered shall contain port, purge per drawing 5006825 and ball valve screw per drawing 5006823.

### 6.3 Definitions.

6.3.1 Damage. Breakage, loosening, shifting, evidence of corrosion, or failure of any finish, hardware, connection or component; and any degradation of cooler performance to values less than specified herein.

6.3.2 Existing suppliers. Suppliers who are currently supplying equipment to this specification with a minimum average monthly rate of 10 units per month over the most current 12 month period. If a supplier cannot maintain the minimum monthly average, a first article test (less reliability) performed annually shall sustain the existing supplier's status when performed on 3 units manufactured by the supplier explicitly for this test.

6.3.3 Lower mean time to failure. The term "Lower" is used to define that value which is the least operational capability and/or the maximum operating and support cost burden the Army can tolerate and accept. This distinction is made to aid the system designer in allocating reliability characteristics of the device.

6.4 Design note. New coolers may see the input power increase when tested with a Devar (0.4 WHL). The input power may increase from 50 w to 53 w at +23°C ambient temperature and from 55 w to 60 w at +71°C ambient temperature.

CUSTODIAN:  
Army CR

PREPARING ACTIVITY:  
Army CR

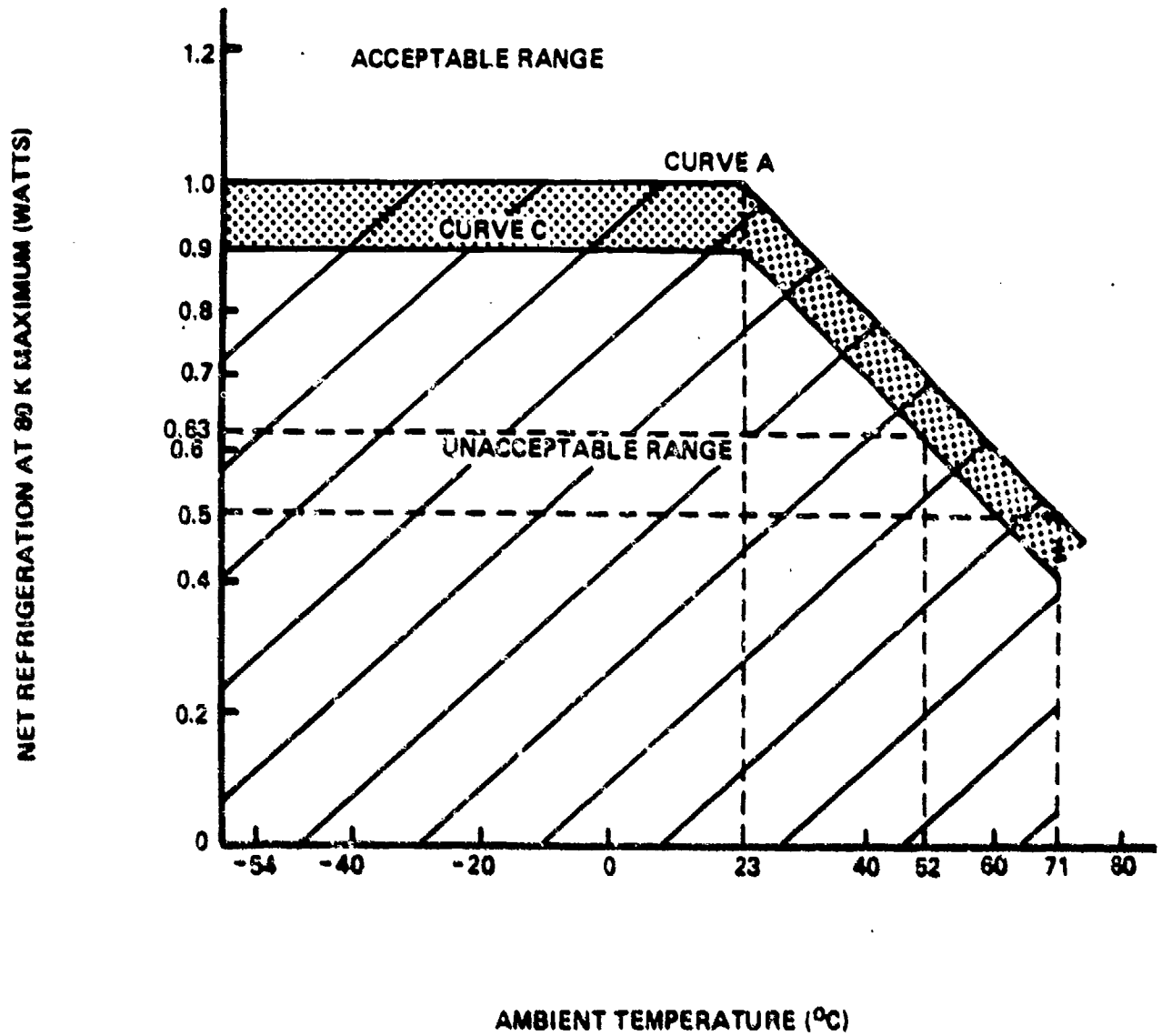


FIGURE 1. Cooling capacity.

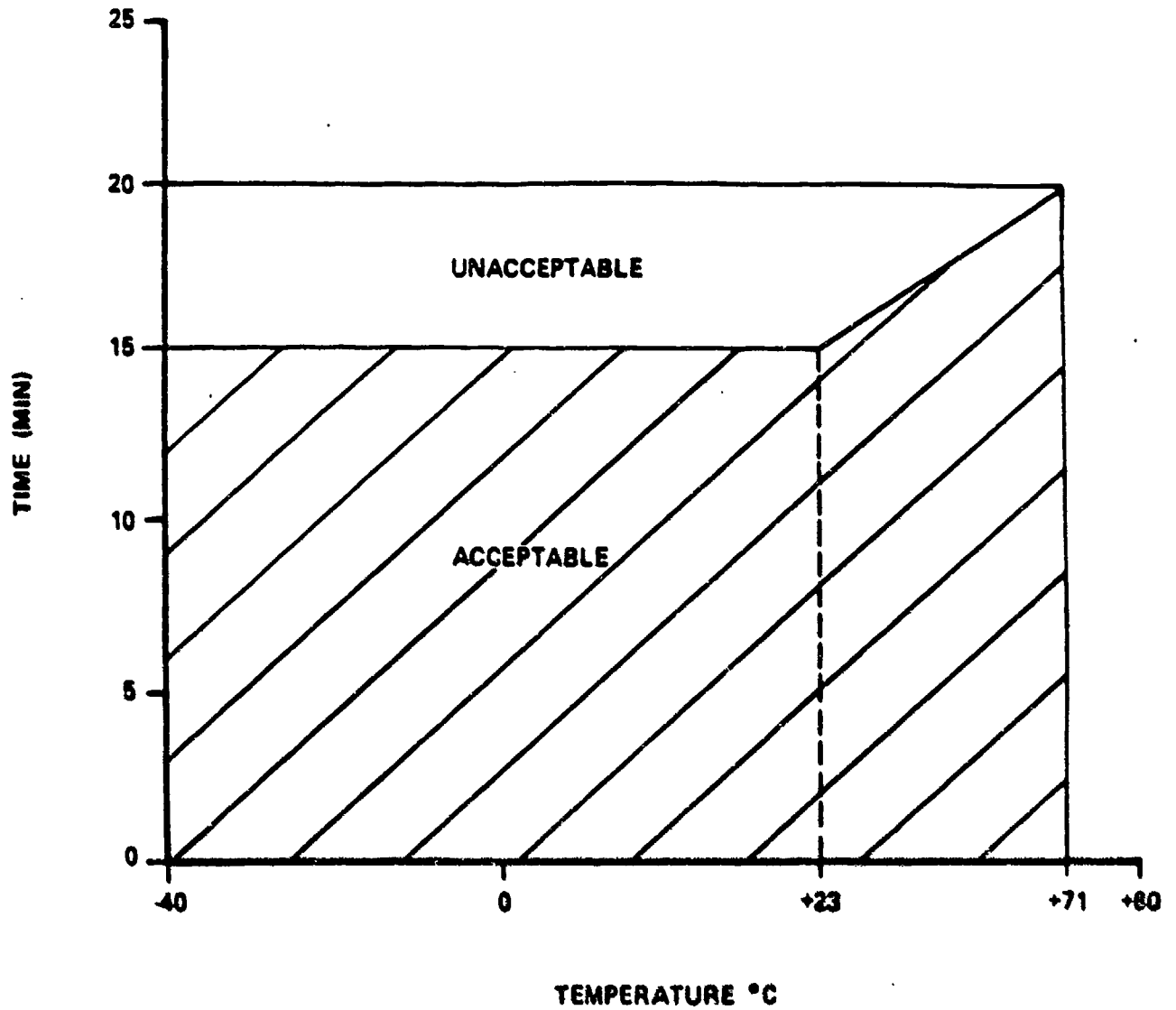


FIGURE 2. Cool down curve.

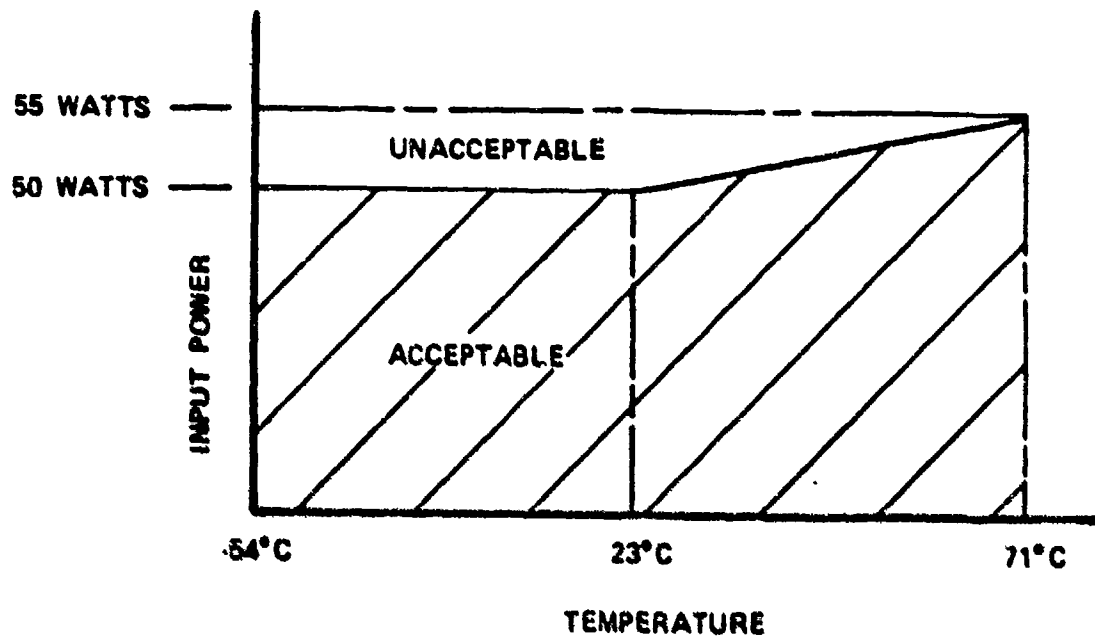


FIGURE 3. Input power with heat load applied.

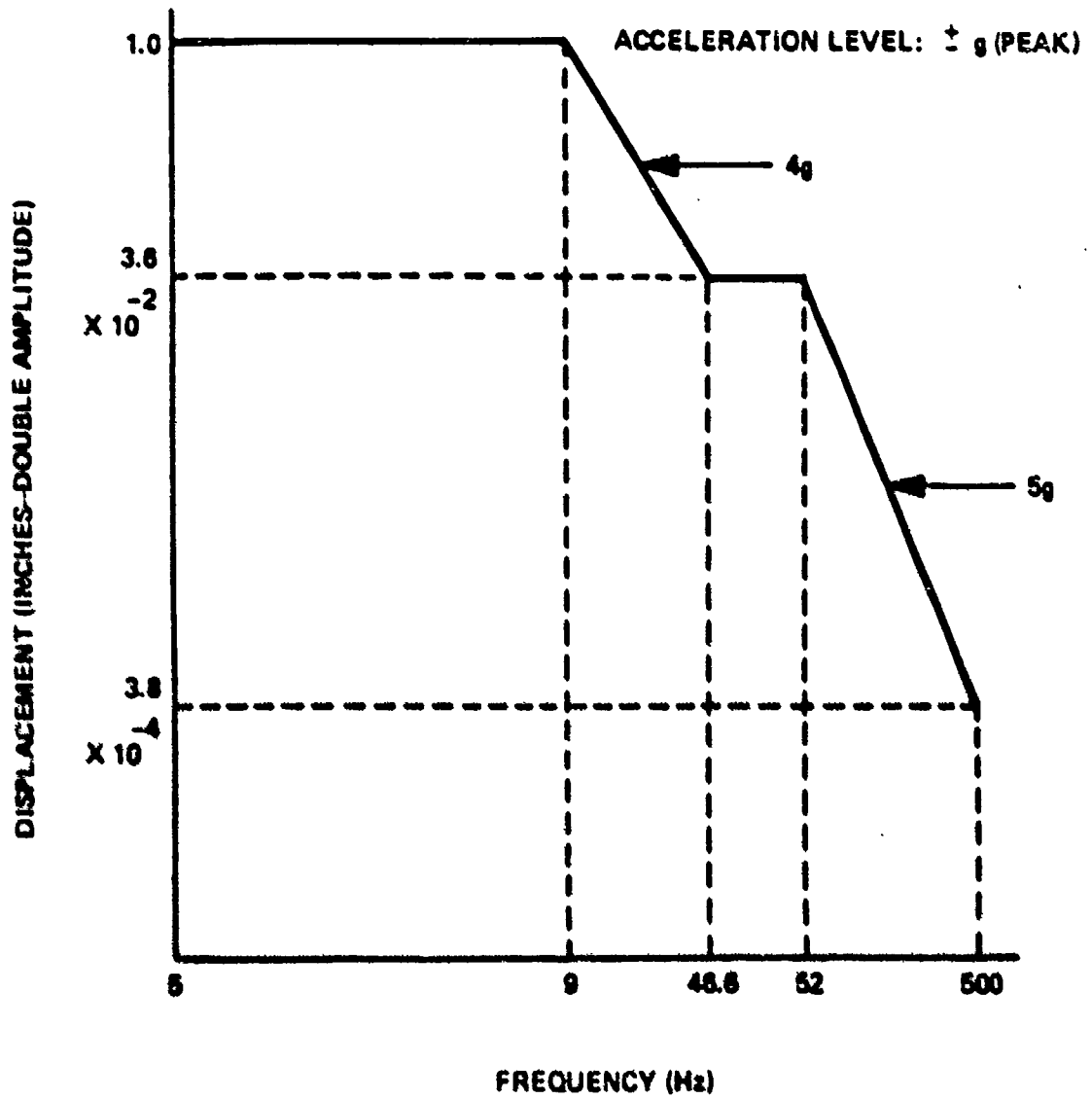
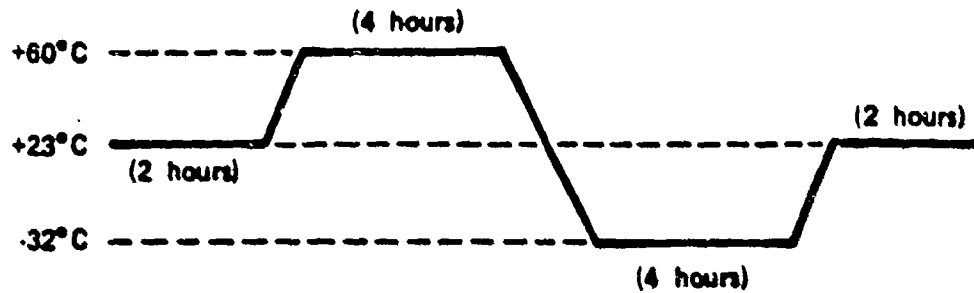
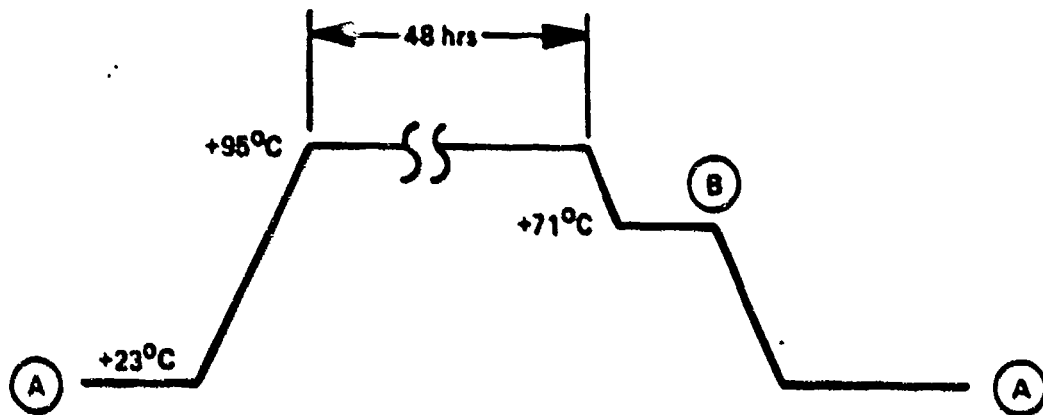


FIGURE 4. VIBRATION TEST PROFILE



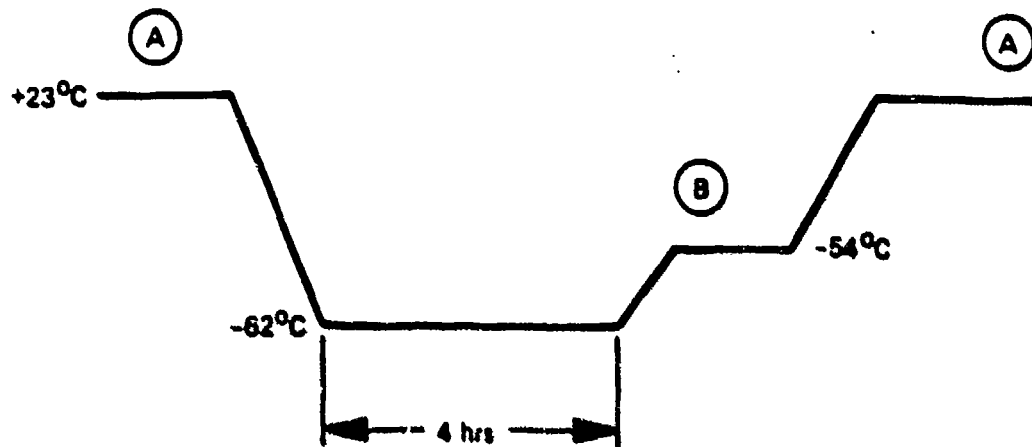
- 1) CHAMBER TEMPERATURE EXTREMES SHALL NOT VARY MORE THAN 5°C PER HOUR.
- 2) RATE OF CHAMBER TEMPERATURE CHANGE SHALL AVERAGE LESS THAN 5°C PER MINUTE.
- 3) UNIT OPERATES THROUGH FULL CYCLE.

FIGURE 5. Burn-in.



- (A) GROUP A TESTS (TABLE III) ARE CONDUCTED AT THESE POINTS.
- (B) COLD FINGER TEMPERATURE WITH 0.5 WATT APPLIED HEAT LOAD MONITORED AT THIS POINT TO VERIFY ABILITY OF COOLER TO MAINTAIN 80 K TEMPERATURE.

FIGURE 6. HIGH TEMPERATURE TEST PROFILE



- (A) GROUP A TESTS (TABLE III) ARE CONDUCTED AT THESE POINTS.
- (B) COLD FINGER TEMPERATURE WITH 0.8 WATT APPLIED HEAT LOAD MONITORED AT THIS POINT TO VERIFY ABILITY OF COOLER TO MAINTAIN 80 K TEMPERATURE.

FIGURE 7. LOW TEMPERATURE TEST PROFILE



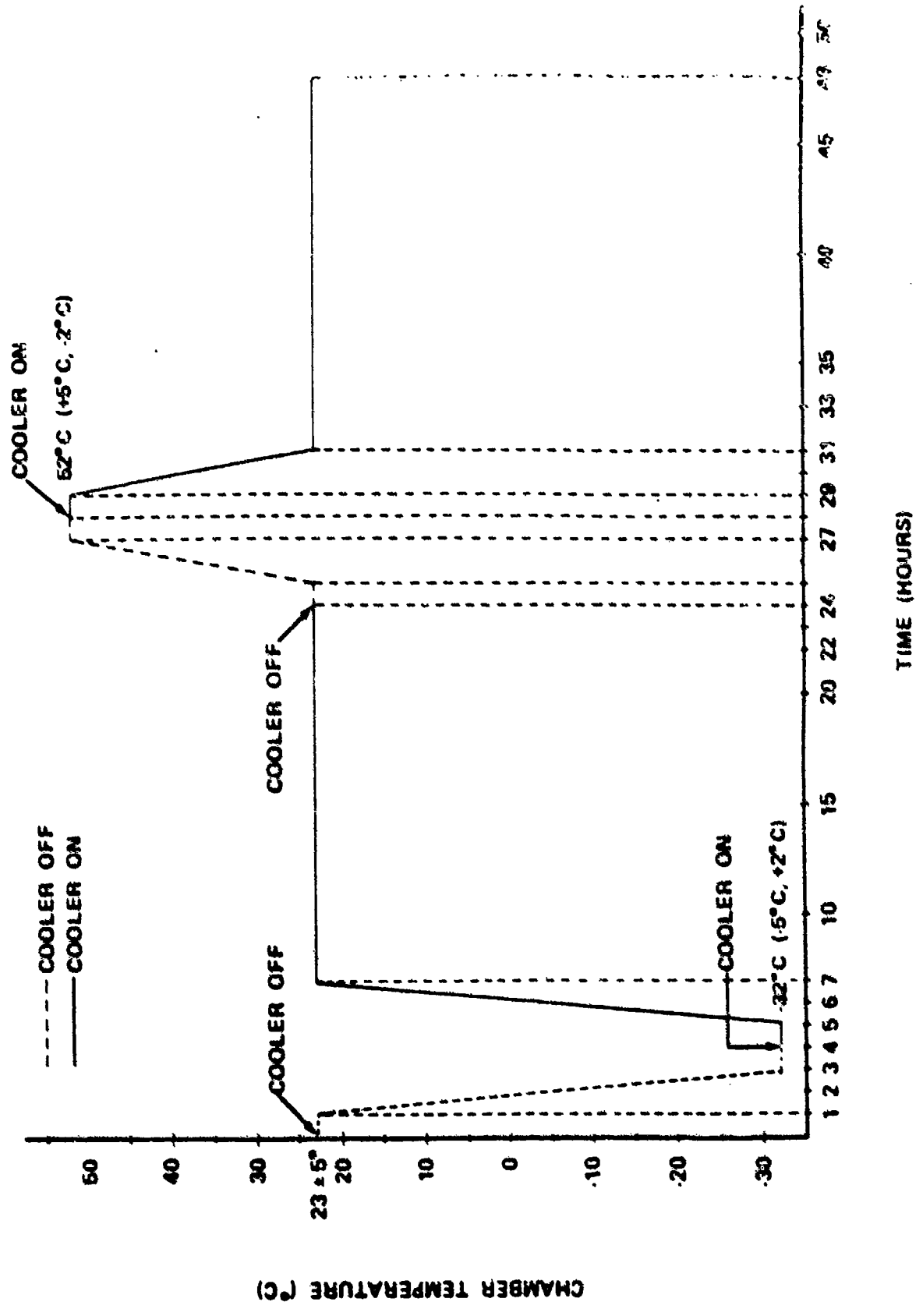


FIGURE 8. Reliability test.

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